F1 2026 Our experts unpick powertrain and brake regulations as dawn of a new era approaches

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UK £6.95 / US $16.25
September 2025 / Vol 35 No 9

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NASCAR continues to evaluate torque sensors with a view to opening up the choice of engines in future, while also keeping competition numbers high

Daylon Barr / Red Bull

COVER STORY

6 Racing Bulls
Chief technical officer, Tim Goss, on the VCARB 02

COLUMN

5 Andrew Cotton
The rising popularity of racing as shown in film

FEATURES

14 F1 2026
Peter Wright on the challenges to be faced

22 Formula 1
New demands on braking systems for next season

28 Lamborghini GT3
Under the skin of the all-new Temerario racer

36 Ginetta GT2
The constructor hoping to spark interest in customer racing

40 Ferrari GT3
Advanced aero and cooling package for next year's 296 Evo

44 Formula Student
Report from the UK competition at Silverstone

53 Sports Prototypes
How Jenvey Dynamics is proving its products in competition

TECHNICAL

60 Torque sensor electronics
Why prolific system adds complication for teams

69 Danny Nowlan
The importance of increasing grass roots range for all

BUSINESS

72 FIA presidential race
Tim Mayer on his challenge for motorsport's top job

76 News
Latest cars from Ligier and Land Rover, plus new GT3 compound

79 Chris Aylett
The success of Motorsport Valley

82 Bump stop

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Suspended reality

It's good for the business of motorsport to occasionally just enjoy the ride

A break in the summer schedule means a journey to Ireland, and that usually involves a trip to the cinema. This year, on the crazy Tuesday pricing special at the Brunswick Moviebowl in Derry where it's £4 per ticket, it seemed the right time, and price, to go and watch the *F1* movie.

Usually, I struggle with racing movies as they take their artistic licence, and in many places, this film was no exception. Indeed, there was a moment where I had to disengage my brain and just try to enjoy what was on screen, and I did enjoy it. Park the idea that in a Balance of Performance formula such as GT racing, Sonny Hayes would so easily out perform everyone else at the 24 Hours of Daytona. Or that the technical director of an F1 team would find a mid-season aerodynamic solution overnight, on their own, that would take the team from the back of the grid to the front. Or that a 50-something driver could step into a grand prix car and operate at the level of the fastest drivers on the grid.

While watching it, I couldn't help but think of Bill Auberlen who, at 56-years old, is still smashing it in endurance racing in North America and has lost none of his appetite for racing. Would he beat Max Verstappen in an uncompetitive grand prix car though? He is still mighty quick in the fast corners, but I think F1 might be a bit beyond even him.

Crashing in

All that said, there were some nice touches in the film, and nods to exceptional events that have happened in racing. A mash-up crash scene mimicked one in an F3 race at Monza, mixed with Romain Grosjean's horrifying fireball in Bahrain, which I didn't think was necessary, though both did actually happen. Martin Donnelly's accident in 1990 was used more sympathetically, as was the crash-gate scandal of 2008 where deliberate accidents led to safety cars that benefitted a team mate, and in turn to the banning of various members of staff.

What really shone through was the competitive spirit within the APXGP team, that search for a tenth of a second from everyone that would drive a team, and a car, forward and up the grid. The business deals, the financial risks a team operates under and the skullduggery was quite fun, I thought.

My big test of the film, though, was what my wife and daughter thought of it. Both enjoyed it immensely. It has proven to be the best-selling film produced by Apple so far, at $300m worldwide, making it one of the top grossing films of 2025. That demonstrates the extraordinary reach of the sport today. The film's success is a perfect analogy for how Formula 1 and racing is going, and I wonder what Liberty Media will do with this new-found success.

Motorsport events at Goodwood in the UK offer an unrivalled opportunity to get up close and personal with historic and modern racecars, and well-known drivers of all ages

As Stéphane Ratel recently pointed out, the *Drive to Survive* series has made racing cool again, and Ferrari winning Le Mans has put endurance racing firmly on the map.

Tickets for race week at Le Mans now sell out within weeks and, based on official numbers, a record 332,000 fans attended the event this year. Grands prix are similarly well attended, despite the higher ticket price.

Other headline motorsport events, such as the Goodwood Festival of Speed, have changed dramatically in the past couple of years. From sending a few rather stunning cars up the hill, the Festival has become exactly that. This year, on Friday – the day you used to go if you were 'in the business', to avoid the crowds – it was rammed, and the Red Arrows had to navigate their way around the fireworks that were launched mid-afternoon. I can't imagine what it was like on Saturday and Sunday, but I'm glad I wasn't there.

Fairground attraction

The big attraction of Goodwood is that fans can get up close and personal with cars of all ages and drivers of all eras. I nearly got run over by a Mercedes F1 car when its driver took a wrong turn; had a chat with GM Motorsport boss, Eric Warren, as he walked past the Le Mans-winning Audi of 2000; talked to Wayne Taylor, who was driving Jody Scheckter's Wolf up the hill as part of F1's 75th anniversary celebration, and then moved on to the launch of the Lamborghini Temerario GT3.

While this launch was well done, it remains a mystery to me why sportscar teams and manufacturers reveal their cars at Goodwood. Porsche did so with its 963, before Lamborghini presented the show model of its SC63 a year later, and now the Temerario. This, in a country that hosts no round of the FIA WEC, (although management says it is working on it, encouraged by 26,000 pre-race ticket sales for the ELMS race at Silverstone in September).

Motorsport has a new-found fan base, and organisers are responding. Fireworks and music concerts are now *de rigueur* at events, so fans get more for their money than just what's happening on track. I just hope the racing itself doesn't get swept away in the hyperbole. It is still facing challenges, from the car industry and politics, and from a technology standpoint the rule makers are committing to strategies that might not work out.

Next week's film at the Moviebowl is *Superman*. I don't imagine genuine superheroes enjoy his films, but maybe they too can suspend reality for a bit and just enjoy The Show.

Motorsport has a new-found fan base, and organisers are responding... I just hope the racing itself doesn't get swept away in the hyperbole

Bulls on parade

Racing Bulls had a strong start to the 2024 season before its form waned. The team is taking action and learning to ensure that story won't repeat itself this year

By **DANIEL LLOYD**

'That painful experience [at the Spanish GP in 2024] was good learning for us. It was a test case to then allow us to put value on the importance of the characteristics of aerodynamic delivery over just general load'

Tim Goss, chief technical officer at Racing Bulls

In a press conference ahead of the Miami Grand Prix, round six of the 2025 Formula 1 season, Yuki Tsunoda was asked (as he has been many times) about his struggles adapting to the Red Bull RB21. The Japanese driver had taken up the poisoned chalice of the second Red Bull seat; having contested the opening two rounds with Racing Bulls, he replaced a struggling Liam Lawson at the former champion team, only to immediately inherit the New Zealander's lack of fortune.

'[The] VCARB [02] was a bit more lenient and forgiving with any directions,' revealed Tsunoda in Miami. 'The Red Bull has a sharper, narrower window where it performs.'

This has been the context in which the 2025 seasons of Red Bull and Racing Bulls have played out. The general view is that the former has a very fast car in Max Verstappen's hands, while the latter has one that is slower at its peak but friendlier to different drivers. While that may be a broad judgement about the two Red Bull-owned teams, there is some truth to it. Both Tsunoda and Lawson have said the Racing Bulls VCARB 02 is easier to drive. However, there is more to the team's season than being a yardstick against which to measure the RB21. Racing Bulls has been working to address its decline in form at the end of 2024, continuing to update its car to achieve balanced downforce delivery, as well as opening a new UK engineering facility in advance of the 2026 rules refresh.

The team had a promising start to the fourth and final season of the ground effect regulations. Tsunoda turned heads by qualifying fifth in Australia and then finishing sixth in the China sprint, before his sudden switch to Red Bull. At the halfway stage, the team had scored 36 points, eclipsing its totals from 2022 and 2023, and was only 10 points off its final figure from 2024, despite registering one points finish fewer.

Design priorities

However, half a season only tells half the story. Racing Bulls knows this better than most. It entered the current campaign eager to avoid a repeat of its 2024 trajectory, whereby its scoring was weighted towards the first dozen races, 29 points to 13. This influenced the design priorities that its engineers set for the VCARB 02, which is powered by the Honda RBPTH003 power unit.

'It all stemmed from our performance at the end of 2024, when we considered that we had been out developed by teams such as Haas,' says Tim Goss, chief technical officer at Racing Bulls. 'We looked at why, and one of the main focuses was the general load increase on the car, which you are always looking for. More importantly, we were looking at ways we could exploit the load. By that, I mean bouncing protection. There is no point in having lots of load if you can't get close to [the ground] because the car starts bouncing. Being able to use the load where it matters – through-corner balance and off-centre load delivery, so steer, roll and ride height – that all comes down to the driveability of the car. That was our primary focus over the winter period.'

'One of the main focuses was the general load increase on the car… being able to use the load where it matters – through-corner balance and off-centre load delivery, so steer, roll and ride height – that all comes down to the driveability of the car'

Tim Goss

Goss joined Racing Bulls in October 2024. He previously worked for the FIA as its single seater technical director and, prior to that, was technical director at McLaren

The VCARB 02 completed its first shakedown at Imola in February. Compared to its predecessor, the VCARB 01, it sported much thinner, flatter sidepod radiator inlets paired with thin, vertical slot inlets, an arrangement Red Bull notably deployed in 2024. The front end was also heavily developed, the chord of the first flap above the mainplane increasing and the chord of the inboard section of the second flap becoming shorter. The end of the nose also drooped down more, bring it closer to the ground. When viewed from the side, the end plates became more rounded at the transition from the horizontal plane to the vertical plane.

According to the team, the wing's span-wise loading distribution was modified to promote better quality flow to the rear. An initial version of the 2025 wing was trialled at the previous season's finale in Abu Dhabi.

Significant benefits

Despite those developments, when the launch car arrived, the team wasn't sure it had increased downforce sufficiently to overcome the improvements that had also been made by its midfield rivals.

'On the general load increase, we weren't certain we had delivered enough,' says Goss, 'though we were sure we had delivered significant benefits in the other two areas: being able to exploit the load in bouncing protection and to have a more driveable car.

'While you can have a reasonable view on how much performance you have delivered from simulated offline testing, you don't really know until you get to the track. There are still areas where you haven't got perfect correlation between the offline tools

The team has occasionally struggled with setting its car up stiff enough to make the most of its aero platform, while at the same time managing bumps and kerbs

Racing Bulls made its sidepod radiator inlet extremely small on the VCARB 02, and coupled that with a narrow vertical slot inlet, which enabled the team to open up the area below the sidepod for increased airflow

and [reality]. So, it wasn't until we actually got to the track that we thought we've landed on something good here.'

The VCARB 02 has gained a reputation for accessibility, if there is such a thing in F1. Isack Hadjar made his F1 debut with Racing Bulls this year and, after shaking the unwanted attention from crashing on the Australian GP formation lap, has made an impressive start. The Frenchman delivered Racing Bulls' first points from a grand prix at round three in Japan and has scored just over half of the team's points so far.

Strategic errors prevented points from being scored earlier than Japan, such as when the team kept Tsunoda out too long in the Melbourne rain, and insisted on a two-stop strategy in China, despite low general tyre degradation making that the less competitive choice. However, round eight in Monaco pointed towards learnings from those mistakes, as the team evoked the art of motorcycle speedway team riding by having Lawson back up his pursuers to give Hadjar in front a gap to manage. It resulted in 12 points scored and turned Racing Bulls into a strong midfield contender.

Update trajectory

Racing Bulls was relatively aggressive with its floor updates in 2024, but its developments in 2025 have not followed an obvious trend. This approach had its roots in learnings from its previous update programme. At the 2024 Spanish GP, the team brought a new rear wing, re-profiled sidepod inlet, amended engine cover and modified forward floor to add local load, while maintaining downstream airflow quality. However, that round of updates didn't pay off and set the scene for the team's decline in form.

'We delivered what we thought was a significant aerodynamic upgrade to Barcelona in 2024. All the numbers looked great, [but] we went backwards,' admits Goss. 'We went backwards [in terms of] through-corner characteristics, particularly the balance shift from braking to corner entry to apex.

Overhead comparison of the VCARB 01 from 2024 (top) with this year's VCARB 02. Aerodynamic developments between the two have focused on making the car more driveable

'We have made a huge step forward in terms of understanding how to protect the tyres. We think we can cope across a range of circuit types with low or high-speed characteristics'

Tim Goss

That painful experience was good learning for us. It was a test case to then allow us to put value on the importance of the characteristics of aerodynamic delivery over just general load.'

Ensuring the car delivers downforce consistently through different conditions, such as yaw, steer, roll, crosswind and different ride heights, has been a challenge across the grid.

'You can find more load if you ignore those things, but exactly where you place those trade-offs is something we have all been working on for some time,' adds Goss. 'But to have a case study – as it was for us in 2024 – banked some significant learning. Admittedly, it was a case study that went wrong, but from that we built through 2024 and, more importantly, built further over the winter period with the 2025 car.'

In the first half of 2025, the team brought circuit-specific parts to China, Saudi Arabia (low drag) and Monaco (high downforce) but its performance-related changes have been applied in a steady stream of minor adjustments. The VCARB 02 will continue to receive new parts into the second half of the current season. At time of writing, a new rear corner is planned for Spa and an updated diffuser for Hungary.

'Given that nothing in terms of the aerodynamic components and flow characteristics will carry over into 2026, you don't want to be sinking vast amounts of effort into something this late in the season,' says Goss, 'but we've still got a few small upgrades that we are bringing to the car to stay in the fight.'

One of Racing Bulls' most significant update packages of the campaign came at the Emilia Romagna GP in May. For its home event, the team modified the VCARB 02's underfloor venturi channels and made subsequent adjustments to the floor fence camber and edge winglets.

'We don't seem to have correlation issues, so that's been very positive,' reflects Goss. 'The steps we have made on the car have definitely improved it, and we have registered it with the drivers.'

For its home event at Imola in May this year, Racing Bulls redesigned the forward section of its floor and underfloor venturi channels to increase downforce in that area, while at the same time defining the downstream flow quality

Behind the scenes in the Racing Bulls' garage, showing the tight packaging of cooling systems within the sidepods

Racing Bulls continued to develop its new front wing and aligned one of those updates to the FIA's implementation of stricter load tests to clamp down on bodywork flexibility. In Spain, when the new front wing load tests were enforced, the team introduced new mainplane elements with a lower central section and more load biased towards the inboard side. It also updated the connection between the front wing end plate and tips to reduce airflow losses in that area.

'The updates we made didn't transform the car, we weren't expecting that,' says Goss. 'They are steady steps that keep us in the fight, somewhere near the top, or at the top, of the midfield. So everything we brought from the wind tunnel we have left on the car.'

Tyre control

A weakness of the VCARB 01 was that it would often fail to convert a strong qualifying performance into points on race day. This was largely down to how the car fared over race stints on the Pirelli tyres, something the team needed to try and iron out in the VCARB 02.

'Our race pace was a significant weakness last year towards the end,' admits Goss. 'We could qualify well, but then we were looking over our shoulder all the time. We have made a huge step forward in understanding how to protect the tyres and our tyre degradation. We think we can cope across a range of circuit types with low or high-speed characteristics, or one that is using the softest or hardest tyre in the range. We can cope with them all, but there have been specific races where we feel we have underperformed our potential.'

The Miami and Canadian GPs were examples of this, which Goss reckons could be attributed to how the car rode over the kerbs. Exploiting the car's aero platform to its full potential required a relatively stiff suspension set-up, but that brought with it drawbacks in the bumpier sections. Hadjar candidly described the ride as 'quite terrible' in Montreal, despite having made Q3.

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'You can do those things on one lap,' he said. 'Over 70 laps, it's much harder to be on the very maximum of what the car can do. And we are suffering a lot more compared to the other teams in terms of tyre degradation, especially on the medium, with the graining. But it was a very fine margin with the other midfield cars. It's just that we were on the wrong end of it, [where] usually we're on the opposite side.'

Goss believes Racing Bulls has improved its understanding of how to best use the Pirelli tyres, although it has still struggled on occasion: 'In Bahrain, we didn't get it right. We were protecting the wrong end of the car and suffered as a result. Then in Montreal, we suffered massive graining in the first stint and that compromised our race from then on.'

The new front wing the team introduced in Spain was a response to the FIA's stricter bodywork flexibility tests, but also doubled as a performance-related update. It wasn't a transformation, but a steady step in the right direction

Part sharing

Racing Bulls adopted the 2024 Red Bull suspension for the final two rounds last year, to give it a head start on knowing how to set up this season's car. It was part of Racing Bulls' investigation into why its competitiveness waned towards the end of 2024.

'We were happy that wasn't the reason,' says Goss, 'but we also learned that there was more to get out of the rear end, and so that was built into the 2025 car. It was a useful experience of getting an early read on that suspension to get more out of it in 2025.'

Racing Bulls will therefore keep the RB20-derived rear suspension for the entirety of the current campaign.

'We are satisfied with those [components] for the remainder of the season. We designed our car and characteristics around what we have now and, if we were to change now, we would have to think about subtly changing our set-up learning, aero characteristics and so on. We are not going to do that because this car has a limited life, so we are better off just focusing on extracting the most out of the car we have got.'

The team remains closely wedded to Red Bull from a parts supply perspective, utilising the same power unit, transmission and rear suspension components. Racing Bulls expects this arrangement to continue into the foreseeable future, with no plans to design its own rear end.

'Our model is to take the transferable components that we are permitted to take from Red Bull,' confirms Goss. 'What that does mean is you don't know the reasons why the suspension layout has been chosen by your supplying team, so you have to design your car around that and make the most out of it. We are quite happy with the way we are.'

Although Racing Bulls is primarily based at the ex-Minardi factory in Faenza, northern Italy, it also has aerodynamic facilities in the UK. For several years, the latter was based in an industrial park in Bicester, but moved to Milton Keynes at the start of 2025. This move has increased the capabilities of Racing Bulls' UK division, and the staff count. The team currently employs 150 people there.

'Our UK engineering team is far more than just the aerodynamicists and aero model shop. We now have a full range of engineers from aerodynamicists to designers to race tacticians to vehicle performance engineers'

Tim Goss

'Our UK engineering team is far more than just the aerodynamicists and aero model shop,' explains Goss. 'We now have a full range of engineers from aerodynamicists to designers to race tacticians to vehicle performance engineers. It has been a huge investment, and the benefits of having a nice working environment designed so that people can work together easily cannot be underestimated.

Statement of intent

'I think it has been a big statement from the shareholders on their confidence in us. It was a massive step and more so for the fact that we had completely outgrown the Bicester office, which started as a bunch of aerodynamicists and then, as the team grew, it wasn't suitable at all. I think our offices now would be the envy of most Formula 1 teams, in terms of engineering capacity.'

Racing Bulls utilises many of Red Bull's facilities, such as its wind tunnel in Bedford and its simulator in nearby Milton Keynes. So now that the UK base is up and running, what is on the agenda for Faenza? A smaller-scale simulator was installed there last year, although it's more for driver training than car development work.

'The Italian facility, we are updating it as we can,' says Goss. 'It was the old Minardi building and, like a lot of teams, it has grown and expanded. What we are doing on the back of what we learned from Milton Keynes is recreating in Faenza a working environment where it is easier to interact and work together.'

Easier interaction among engineering teams is clearly a priority for Goss and his senior Racing Bulls colleagues since he became CTO in October. The success of McLaren's leadership structure, involving three departmental technical directors, rather than one, has shown how important it is to have efficiency at the upper ranks. Just before the 2025 season started, Racing Bulls technical director, Jody Egginton, left the team. Instead of sourcing a replacement, his responsibilities were covered between Goss and the two deputy technical directors, Andrea Landi (car design) and Guillaume Cattelani (performance).

'The three of us together are looking after the direction we are going and priorities in terms of performance, design, trades between one project and another,' explains Goss. 'One thing we have brought to the team, which was important for me and Laurent [Mekies, former Racing Bulls team principal] was to get some simplicity and clarity on the organisation structure and responsibilities. It really is clear to everyone how we move forward, along with the split in terms of reporting responsibilities between the factory and the race team.

'When it comes to race activities, to prevent overload for myself and for clarity, you get the engineers that report into me to report to someone trackside, and make it clear during a race weekend that's who they report to. That clarity was important for us.'

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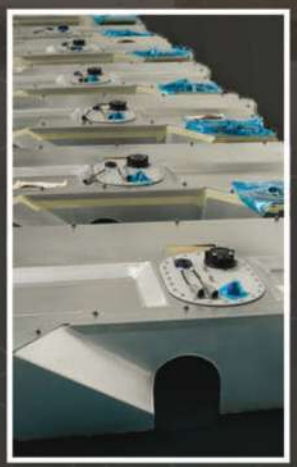

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The show must go on

Racecar's *technical consultant and design expert gives his views on what the 2026 regulations mean for Formula 1*

By PETER WRIGHT

As I write this review of the 2026 Formula 1 technical regulations, I read that Charles Leclerc has been testing next year's Ferrari in the Maranello simulator and has expressed the opinion that it is 'not the most enjoyable.' Leclerc has the luxury of being able to hop from the Ferrari SF-25 into the proposed 2026 car; does he even have a switch on the steering wheel to switch between them?

His comments centre on the powertrain and moveable aerodynamic regulation changes, and what they mean to how a driver manages them, particularly for overtaking. Whether this means a different set of driver skills, or changes the relationship between driver and engineer, we wait to see.

The new cars will be four per cent lighter, around five per cent smaller, and with tyres seven to eight per cent narrower. Downforce should be less, but that depends on the results of efforts made in wind tunnels over the next six months. Drivers should appreciate all these changes, but it is the alterations to the powertrain and to the aerodynamics we will examine first.

Powertrain

In 2014, a new formula was introduced in F1. The FIA, after extensive discussions with automotive manufacturers, wrote a new set of powertrain regulations that put the emphasis on efficiency in the name of sustainability. By including a mass flow limit of a highly controlled E10 fuel, the power output of the engines would be determined by how efficiently the engine could turn that rate of energy flow into mechanical horsepower. Also included was an element of electrical power that could be added to the crankshaft. The source of electrical energy was recovery under braking – as per the KERS system used in F1 since 2009 – and exhaust energy recovery from the turbo.

I suspect this is the last F1 formula with any relevance to road vehicles, before it becomes pure entertainment and the powertrain element is specified solely for the spectacle

This latter proved to be a key technology, involving an electric motor generator unit (MGU-H) directly coupled in series with the turbo, spinning at up to 125,000rpm.

The other key technology was the ability to ignite very lean mixtures in the combustion chamber. The fastest car therefore not only had the most efficient engine, but also a chassis and aerodynamics that allowed the throttle to be open fully for longer.

Of the four manufacturers that took up the challenge – Mercedes, Honda, Ferrari and Renault – Mercedes mastered the technologies quickest and, as a result, will have won 91 per cent of the F1 World Constructors' Championships in the subsequent 11 seasons (if 2025's results follow the current trend). Of the current grid, 40 per cent use a Mercedes powertrain, these being the factory team, Aston Martin, McLaren and Williams.

Audi has geared up its facilities in Neuburg to produce the innovative new power unit, although the regulations are the stuff of engineering nightmares

Perhaps as a result of this domination, the formula is to be changed for 2026, further emphasising sustainability, with a higher percentage of electrical power and renewable, carbon-neutral fuel, in a final push by the fossil fuel and non-Chinese automotive industry for relevance in F1.

Electric spectacle

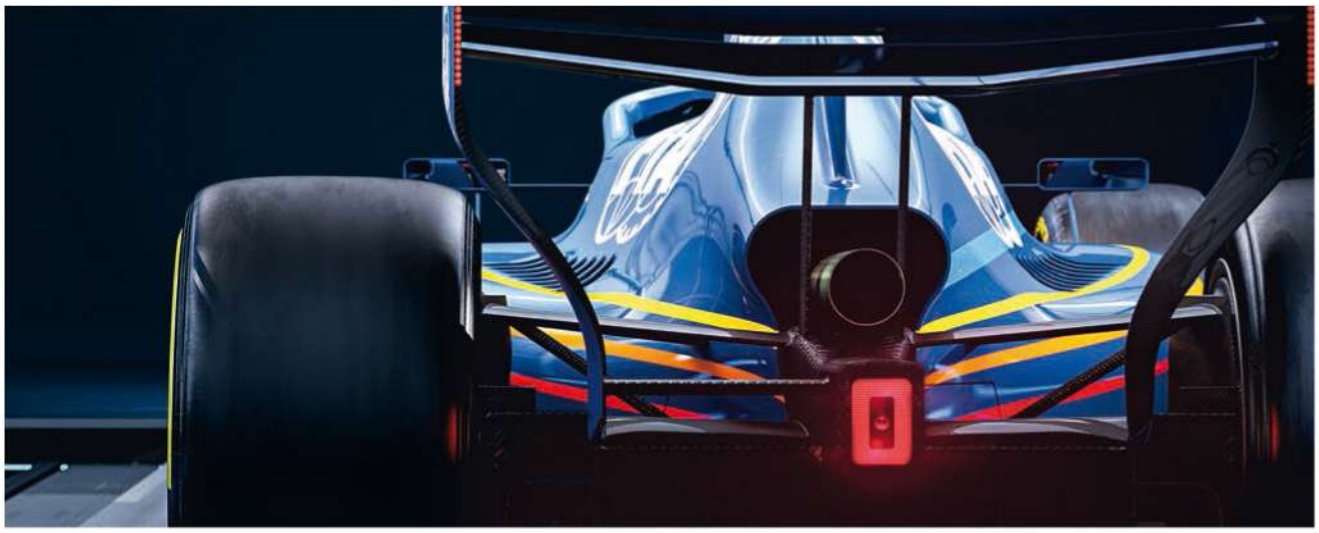
Cars producing 750kW cannot, however, be pure electric if grands prix are to be much over 10-15 minutes in duration, so I suspect this is the last F1 formula with any relevance to road vehicles, before it becomes pure entertainment and the powertrain element is specified solely for the spectacle, eg normally aspirated, V10 ICEs.

Of the powertrain manufacturers, F1 will lose Renault in 2026, but is gaining Red Bull Ford Powertrains, General Motors and Audi, and has enticed Honda back into competition after a short break away.

The core ICE of the new regulations is virtually the same as the current one, but with the elimination of the MGU-H in series with the turbocharger. The effective maximum energy flow rate has been reduced by 30 per cent, so the ICE will produce around 30 per cent less maximum power, but the motor generator unit attached to the crankshaft (MGU-K) has nearly tripled in maximum power. Currently, it can produce up to 18 per cent of the peak power, but in 2026 it will be around 45 per cent, and the source of this electrical energy becomes critical in the absence of any from exhaust gas waste energy recovery.

The new 2026 F1 cars are to be five per cent smaller than the current models, four per cent lighter and with tyres seven to eight per cent narrower

As far as powertrain changes go, greater emphasis is to be placed on sustainability, with the MGU-K component of the maximum power output increasing from 18 per cent currently to around 45 per cent, while an energy flow rate reduction reduces the ICE output by around 30 per cent. How teams manage this energy flow will be critical to success



Energy usage is governed in multiple ways, one of them being recovered electrical energy per lap. When the recovered energy is used up on a lap, drivers will have around 70 per cent of the power available compared to the current generation F1 cars, so the FIA has introduced extensive new aerodynamic regulations in an effort to compensate for this

For 2026, the electrical energy that can be recovered under braking is doubled. The two key technologies for next year will therefore be managing the available electrical energy and adapting to the new fuel. One of the most interesting aspects of this will be to observe which of the automotive heavy hitters will come out on top. It would be rash to bet on anyone other than Mercedes.

Reading the detail of the new regulations for the powertrain erodes one's will to live. Policing the many critical issues concerning energy flows relies on multiple sensors and software, all operating at powertrain typical frequencies, and in real time such that race results are not left in doubt. The FIA has developed an extraordinary ability to perform this task successfully.

Sustainable fuel

The 2025 fuel is a highly controlled E10 petrol (gasoline), delivered to the powertrain at a maximum mass flow rate of 100kg/hour. This equates to 1300kWhr/hour energy flow ie 1300kW peak power. Allowing for 50 per cent thermal efficiency, this becomes 650kW. Total race consumption is 110kg of this fuel, which costs around $30 per litre, or around 15 times the cost of already expensive regular petrol at the forecourt in the UK.

In 2026, the specification of the fuel is freed up, but the flow rate is changed to energy flow rate, instead of mass flow

In 2026, the specification of the fuel is freed up, but the flow rate is changed to energy flow rate, instead of mass flow. The key attribute of the fuel is that it must consist only of certified Advanced Sustainable (AS) components, derived from a renewable feedstock of non-biological origin (RFNBO). This basically means the feedstock must not be from a food energy crop, be grown on land with high biodiversity, or on high-carbon land, such as wetlands or peatland. The hydrogen component of the resulting hydrocarbon must be generated using renewable electricity for electrolysis.

Obviously, this all requires consistent certification standards and, while teams will collaborate with their fuel suppliers (Aramco, BP, ExxonMobil, Petronas and Shell), the FIA is establishing the Sustainable Racing Fuel Assurance Scheme (SRFAS) to ensure the fuel meets specific sustainability and performance criteria. The SRFAS, developed by Zemo Partnership and the FIA, will certify the fuels, ensuring they come from appropriate feedstocks and meet stringent greenhouse gas emissions thresholds.

Energy flow

Fuel energy flow rate is 3000MJ/hour, equivalent to a maximum fuel power of 833kW. What the 2026 powertrain efficiency will be for the new engines, now that the MGU-H is deleted, is not yet clear, but this fuel power is 64 per cent of the current.

The main purposes of the Aerodynamic Components section of the 2026 technical rulebook is to reduce downforce and drag. Part of this will come from the overall reduction in car size, but also from a narrower and flatter floor and a less powerful diffuser. Current estimates suggest the combination will result in between a 15 and 30 per cent overall drop

To achieve such a significant reduction in drag, yet keep the racing spectacle and overtaking opportunities, active aerodynamics are making a return to F1. Cars will have variable front and rear wing flaps that allow drivers to switch between a high-downforce, straight-line mode and a low-drag cornering mode. DRS has now been abandoned entirely

Total fuel for a race, meanwhile, is coming down to 70kg, or 64 per cent of current, so that all makes sense.

However, it has been rumoured that the new fuel will cost $300 per litre, or around 150 times the cost of UK forecourt fuel. There may be accounting issues in how it is costed, and one should never confuse cost and price, but that is still a strange message to put out about sustainable fuels. Unless, of course, one is strongly against them and sustainability…

One anomaly, which may be a contributor to Leclerc's comments on driving Ferrari's 2026 car in the simulator, is that the metering of energy is governed in three different ways:

- ICE power: fuel energy per hour.
- Total ICE energy: fuel energy per race = fuel energy per km.
- Recovered electrical energy: electrical energy per lap.

Apart from Monaco, all grand prix race distances are set at the required minimum of 305km (190 miles). Lap distances vary from 3.3 to 7km (2.1 to 4.4 miles), the longest being Spa-Francorchamps with its power-hungry straights, which will have the least available energy per km (1.2MJ per km or 1.93MJ per mile), on average around a lap. Monaco, the shortest circuit with a reduced minimum race length of 260km (162 miles), will have 2.49MJ per km (4MJ per mile), while Austria, the next shortest, but also power hungry, will have 1.93MJ per km (3.1MJ per mile). It remains to be seen whether overtaking at Monaco will be improved.

When the recovered energy is used up on a lap, the driver will have only around 70 per cent of what they are used to in 2025, and so the FIA, fully aware of this, has set out to solve the problem of top speed with new aerodynamic regulations.

Aerodynamics

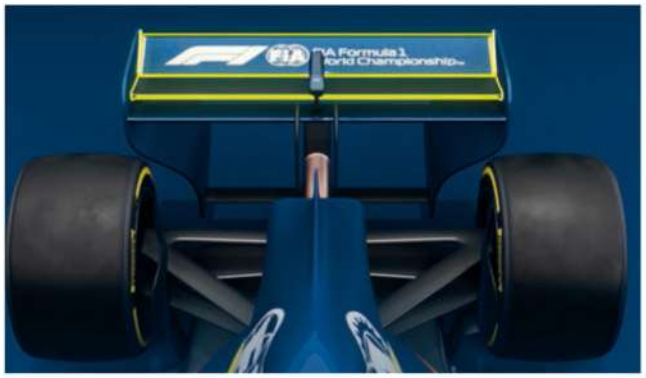
There is a whole swathe of new regulations under Article 3, Aerodynamic Components, in the 2026 technical rulebook. Cutting to the chase, they have two primary purposes: firstly, to reduce downforce, and secondly, to provide for a drag reduction to compensate for the issue outlined above.

To reduce downforce, the cars will be around five per cent shorter, five per cent narrower and with a five per cent narrower front wing. The floor, meanwhile, will be eight per cent narrower and flatter, with a less powerful diffuser. How these, and many other aerodynamic details, pan out after hours of wind tunnel running and teraflops of CFD, remain to be seen (post Austrian GP, teams were abandoning their 2025 programmes to concentrate their resources solely on their 2026 cars). Current estimates vary quite significantly between a 15 to 30 per cent overall reduction.

In order to achieve such a significant drag reduction, it has been necessary to introduce variable front and rear wings, such that the car can be changed from a high-downforce configuration (straight-line mode) to a low-drag configuration (cornering mode). This is achieved by moving the wing flaps at both ends of the car.

A main purpose of the 2026 changes is to make the racing more entertaining, which means closer racing, more overtaking and a less predictable result

DRS open or closed has been pretty much the limit of moveable aero in 2025, but all that will change for the next season as power management will become a key performance differentiator



Unlike DRS, the dual-mode aero system for 2026 can be used at any time within certain zones that will be specified by the FIA for each circuit. The idea is for it not to be an overtaking aid, but a means of balancing top speeds

The concept of using a variable, drag-reducing rear wing for overtaking (DRS) under certain allowed conditions has been abandoned. DRS, while being a pure performance aid during qualifying, and a means of enabling a following, faster car to compensate for the loss of downforce experienced in the wake of a leading car, actually became a means of a slower car overtaking a faster car on the straight. The dual-mode system for 2026 can be used at any time, within certain safety constraints and zones, to be defined by the FIA for each track. It is therefore purely a means of ensuring similar top speeds between cars and, as both leading and following cars can use it, will have little effect on overtaking.

Whether top speeds are the same in 2026 as they are currently is of no real interest to drivers, or fans, as long as it is equal for all.

Chassis changes

The key changes for the chassis – monocoque, suspension, brakes, wheels, tyres and systems – are the minimum weight, which is reduced by four per cent, and the tyre widths, which are reduced by eight per cent front and 7.5 per cent rear. These changes are designed to make the cars more raceable, easier to overtake (less front wing and suspension damage, more near misses), and further increase the need to manage tyre temperatures and degradation. There are also detail changes to make the safety cell stronger to better protect the driver within.

Policing the regulations has become an onerous task for the FIA, and changes have been made to try and simplify the process. Checking for the deflection characteristics under load of the aerodynamic components is just as critical today as it was when moveable aero was first banned in the 1960s.

A main purpose of the 2026 changes is to make the racing more entertaining, which means closer racing, more overtaking and a less predictable result. The problems with overtaking arose when racecars, F1 in particular, developed downforce, generated by fitting front and rear wings, and subsequently ground-effect undertrays. Before such devices, the following car experienced less drag and lift than the car ahead, which meant it cornered faster and accelerated quicker down the straight, allowing it to pass the leading car. When lift turned negative, there was a downforce loss in wake, and the subsequent cornering speed reduction meant a following car could never get close enough in a corner to benefit from the lower drag and overtake.

DRS provided a lasting solution, but has never been much loved. After 15 years, it is now replaced by a Manual Override Mode (MOM) of the MGU-K, to provide a power boost relative to the car ahead. The conditions for use will be the same as for DRS; the following car must be within one second of the car ahead. The leading car can use its MGU-K up to a speed of 290km/h, after which it reduces to zero at a speed of 355km/h. The following car has the benefits of its MGU-K up to 337km/h, so *may* be able to overtake. This all depends on the energy available to each driver, recovered at a maximum rate of 8.5MJ/lap and stored in the car's battery (ES), which can hold a maximum of 4MJ. So, if a driver starts a lap with a fully charged ES, they have a potential 12.5MJ on tap to catch and pass a competitor during that lap.

While the driver interprets their displays to determine information on energy levels, and whether they have sufficient to attempt a passing manoeuvre, they must also decide when to deploy straight-line mode, which sets their car up for minimum drag (provided the FIA does not make that decision for them). The earlier in the exit of a corner a driver can, or is allowed to, do this, and provided they can handle the loss of downforce, the quicker they will be on the following straight. Of course, though, their opponent ahead will be doing the same…

Strategic planning

All the regulation changes noted here interact in terms of qualifying speed, race start, race speed, tyre degradation and the optimum use of active aero and the MGU-K at any given moment. Plus individual team / driver pit stop strategy. How these systems are used may be under the control of on-car software, the race engineer who interprets off-car analysis and simulation software (aided by AI?), or the driver. The race engineer cannot directly change on-car settings while the car is moving, so must instruct the driver what to do under race conditions. This should certainly liven up the radio conversations between the pit wall and the drivers, if, as viewers, we can ever understand what the driver is being instructed to do.

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The FIA has allowed more pre-season testing but, while this might reveal some answers about the new powertrains, it will probably not answer the questions about how drivers will use the new aerodynamic modes and MOM

Audi presented a loose rendition of its 2026 car when it revealed its project, but the real thing will be quite different

When I was briefed about writing this piece, I was asked what areas I would find most interesting in the 2026 F1 cars. Certainly, the 2026 cars will look a bit different to the 2025 ones, but most of the changes will be hidden from view. However, the powertrain regulations are fundamentally different and it will be fascinating to find out which of the five, plus an additional one in 2029, fares best.

Mercedes, Ferrari and Honda, who have some 11 years' experience of fuel flow rate-limited, turbocharged, 1.6 litre V6s in F1, along with an MGU-K and energy store, must start with an advantage, but both Ford and Red Bull, plus Audi, are technically astute, and have a wide experience of racing engines to call upon. We won't see the details, but who best exploits the new regulations for ICE, MGU-K and sustainable fuel will quickly become apparent. Under the new regulations, the FIA has allowed more pre-season testing (11 days vs three days in 2025) but, while this might reveal some answers about the new powertrains, it will probably not answer the questions about how drivers will use the new aerodynamic modes and MOM.

The five-day test at Barcelona in January, where each team can run their car for up to three days, will be carried out behind closed doors; we will only be party to lap times and any comments made public from drivers and team members.

Teams will be running their new powertrains on track for the first time there, and simulation predictions of how best to use the rationed, recovered MGU-K energy for straight-line performance, as opposed to for overtaking, will be validated. Drivers will have their first chance to explore outside the simulator the optimum point to dump downforce on corner exit in exchange for better acceleration down the straight, but only if the FIA allows them to make that decision when it sets up the circuit zones.

Final preparation

Meanwhile, Pirelli will be finding out how its new, narrower tyres stand up with less downforce, and the FIA will discover how lap times and top speeds compare with 2025. We may expect some fine tuning of the regulations after the Barcelona test.

We will also read about a Cadillac in F1 for the first time ever, and how this young organisation is developing technically.

We may also discover whether any of the other teams have worked out how McLaren has gained control over tyre temperatures and degradation, especially while closely following another car.

A pair of three-day tests in Bahrain in February will be more of the same, only in a higher temperature environment, and we will be able to follow this more closely, but none will test the new rules under race conditions.

Whether the FIA sets up the MOM zones for overtaking during the tests will determine whether teams, who can only run one car, will have a chance to use their competitors to test overtaking. This will require the latter's cooperation.

All this data will then be put into race simulations in preparation for the Australian Grand Prix in March, when we will finally find out if the new regulations really do improve the racing, and whether Charles Leclerc, and his fellow drivers, actually enjoy driving and racing the 2026 cars.

Felipe Drugovich testing the 2026 tyre in a mule car that is the nearest Pirelli has been able to get to understanding the downforce levels it expects to see from the cars in 2026

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Under pressure

F1 braking demands will change considerably in 2026. Racecar *investigates how and why*

By DANIEL LLOYD

The next generation of Formula 1 cars arriving in 2026 will introduce different demands on braking systems and fresh challenges for the car designers. As one team engineer put it to *Racecar* at this year's Spanish Grand Prix, brakes have become technologically consistent and dependable, the last major overhaul coming at the dawn of the hybrid powertrain era in 2014. That's not to say complacency has crept in, though, because other regulatory updates have taken place and teams haven't stopped in their quest to instil driver confidence with precise pedal feel.

However, the upcoming rule changes are set to give teams a lot to consider and potentially make braking systems more of a talking point, and a headache, than they have been for many seasons. Key factors influencing brake design in 2026 include higher regeneration from the MGU-K, narrower tyres and active aerodynamics. How each team works with its suppliers to develop a system that balances the requirements of these aspects, and more, will contribute to determining which car is fastest out the gates, and who needs to play catch up. After all, you can have the slipperiest car in a straight line and something that holds well through the corners but, if it can't slow down effectively, it won't be going round any track quickly.

Braking basics

F1 braking systems consist of many components working in conjunction. Unsurprisingly, the system on the front is different to the system at the back. At the front, the driver's pressing of the left pedal causes brake fluid to apply pressure to pistons in the calipers. Since brake fluid has extremely low compressibility, the time between input from the driver and output at the wheels is almost instantaneous. The hydraulic pressure compels the pistons to clamp up to four pads onto the brake discs, creating friction that slows the wheel's rotational speed and converts its kinetic energy into heat energy.

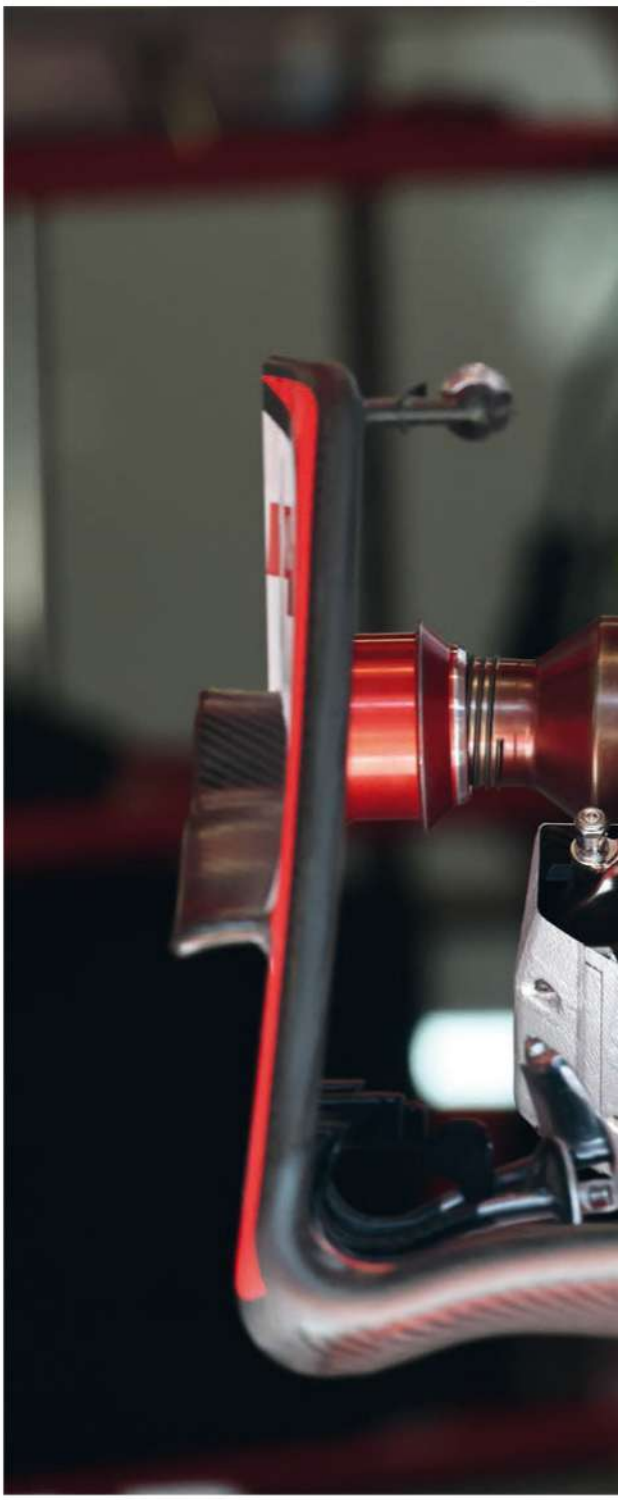
At the rear, this mechanical friction only accounts for part of the deceleration. The power unit has an important role to play too, mainly through regenerative braking which takes some kinetic energy from the moving wheels when the driver brakes and converts it into electrical energy that is stored in a battery (up to 8.5MJ per lap in the 2026 cars). This stored energy is then re-deployed to the wheels, renewing the usefulness of energy that is otherwise used once and tossed in a hydraulic system. A complex electronics package, including brake-by-wire, controls how much energy the MGU-K takes from the wheels per lap, and when.

What's new?

That's the basics of F1 braking systems outlined, but what is changing with the arrival of the new cars in 2026? To answer this, it is perhaps best to first understand what is staying the same. The cars will retain a system whereby a single pedal in the cockpit operates a pair of master cylinders, one for the front and one for the rear. Any modulation of the braking system, such as brake bias adjustments, must be carried out by the driver's physical input. Each wheel has a single disc and a maximum of two brake pads. Liquid cooling of the brakes, and asymmetric braking, are both forbidden.

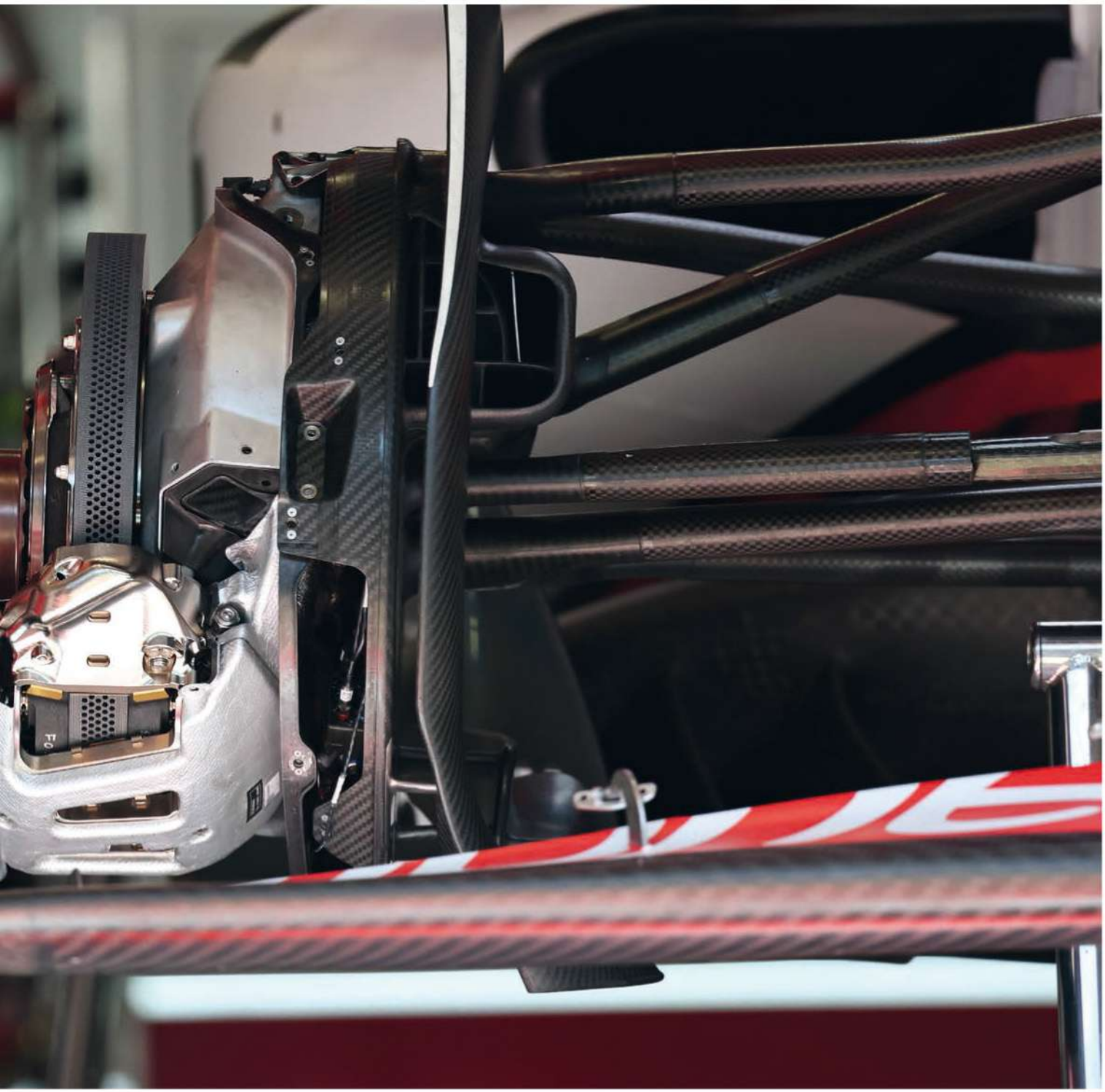
That brings us on to what is different. The maximum thickness of brake discs has increased from 32 to 34mm. The front brake discs can now be larger (maximum diameter increased by 15mm) while the rears can be smaller (minimum diameter reduced by 15mm). The minimum diameter of the cooling holes around the rim of the disc has also been reduced, from three to 2.5mm.

There are now more possibilities in caliper arrangement. Previously, each wheel had one caliper containing up to six pistons, whereas



'The 2026 rules will be completely different from what we have now, in terms of braking systems. We won't have a single piece of metal equal to what we have now'

Mario Almondo, chief operating officer at Brembo Performance



Formula 1 brakes are highly effective works of art, and each team works closely with its suppliers to develop bespoke systems that meet individual car and driver needs

from 2026, each wheel's caliper may have between two and eight pistons, and up to four pads. The attachment system has also been changed, allowing for up to six mounting points.

There is also a new requirement for the rear braking system to be capable of providing 2500Nm of braking torque at each rear wheel, without assistance from the power unit. This torque target must be achieved with a maximum caliper pressure of 150barG. The hydraulic pressure in the rear braking system cannot exceed 1.2 times the pressure generated by the corresponding driver input to the master cylinder. This is controlled by power electronics.

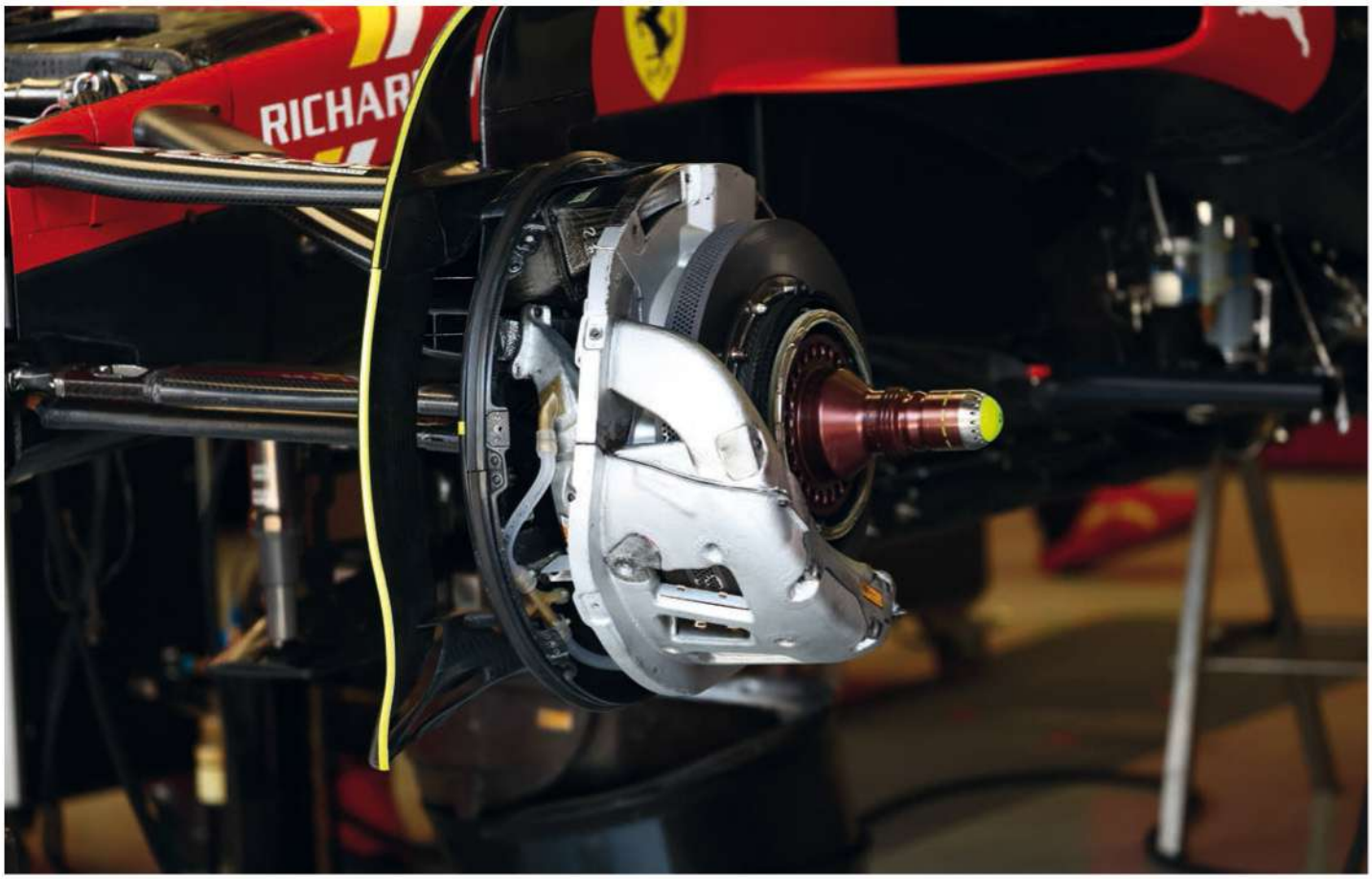
Clearly, then, more things have changed than have stayed the same. This has made the last few months an extremely busy time for the brake system suppliers (see box out on p24), who work with each team to develop components that suit its car's characteristics.

'The 2026 rules will be completely different from what we have now, in terms of braking systems,' posits Mario Almondo, chief operating officer at Brembo Performance. 'We won't have a single piece of metal equal to what we have now.'

Dan Woodcock, principal design engineer at AP Racing, adds: 'The 2026 regs have opened up brakes a lot, probably more so than the last 20 years, with different caliper mounting options and different amounts of pistons and pads allowed, for example. That has certainly given us a lot to look at, to make sure we're not missing a trick.'

Milestone moment

'The front, broadly, is similar to now, but [MGU-K] regeneration is jumping massively, which is giving plenty of problems and avenues for development. We're making our



How teams utilise the increased energy regeneration available from their MGU-Ks will have a major influence on rear hydraulic braking system design

own predictions and calculations, and trying to make sure we're covering all bases with design, simulation and testing.'

New braking demands and requirements are the result of changes to fundamental areas of F1 car design from 2026. For the suppliers, the headline topic is the huge increase in electrical energy being produced by the MGU-K. An electric motor that currently produces 120kW will be uprated to 350kW; this corresponds with a near-threefold increase in regeneration that helps to slow the rear wheels even more.

'Clearly, the most important [influence on braking systems] is the regenerative power,' confirms Nikolas Tombazis, single seater director at the FIA. 'Hence, a bigger proportion of electrical energy will be converted to the rear. However, we have other factors which affect how brakes will be used. These include the fact that engines will have a bit more turbo lag, potentially affecting how we will use the electric motor to compensate. We don't, therefore, have a complete picture of where we will end [up] on that topic.'

Greater MGU-K regeneration reduces the workload of the rear hydraulic brakes. Hence why the rear brakes can be smaller in 2026. When we say the brakes can be smaller, that doesn't refer to the discs. While the minimum rear disc diameter has been reduced from 275 to 260mm (about five per cent), disc diameter has more of an effect on braking torque than absorption of kinetic energy. An upper rear disc diameter limit of 280mm remains in place, so there will be more options for brake disc size than there are today, though teams are expected to shoot for the lowest and lightest value. Calipers don't have any similar size restriction, so these can be downscaled depending on the needs of each car.

Rear view

That is not to say F1 teams will do what the FIA Formula E World Championship tried in 2023 and delete the rear hydraulic braking system altogether. That bold move for the Gen3 car didn't make it very far before a secondary, hydraulic brake system was introduced on safety grounds, in conjunction with Brembo. Tombazis reckons banishing rear hydraulic brakes in a top-level single seater is 'a step too far' and not something that could work in F1 just yet. How to stop the car in the event of an MGU failure remains a conundrum. That said, teams and suppliers are investigating ways of making the rear hydraulic brakes smaller, to reduce weight without impacting the car's ability to slow down. Almondo projects the rear brake systems used in F1 could be up to 20 per cent smaller, although the discs are of course limited by the prescribed size window.

'The percentage of the total rear braking that happens electrically has the potential to be much higher in 2026,' says Williams Racing

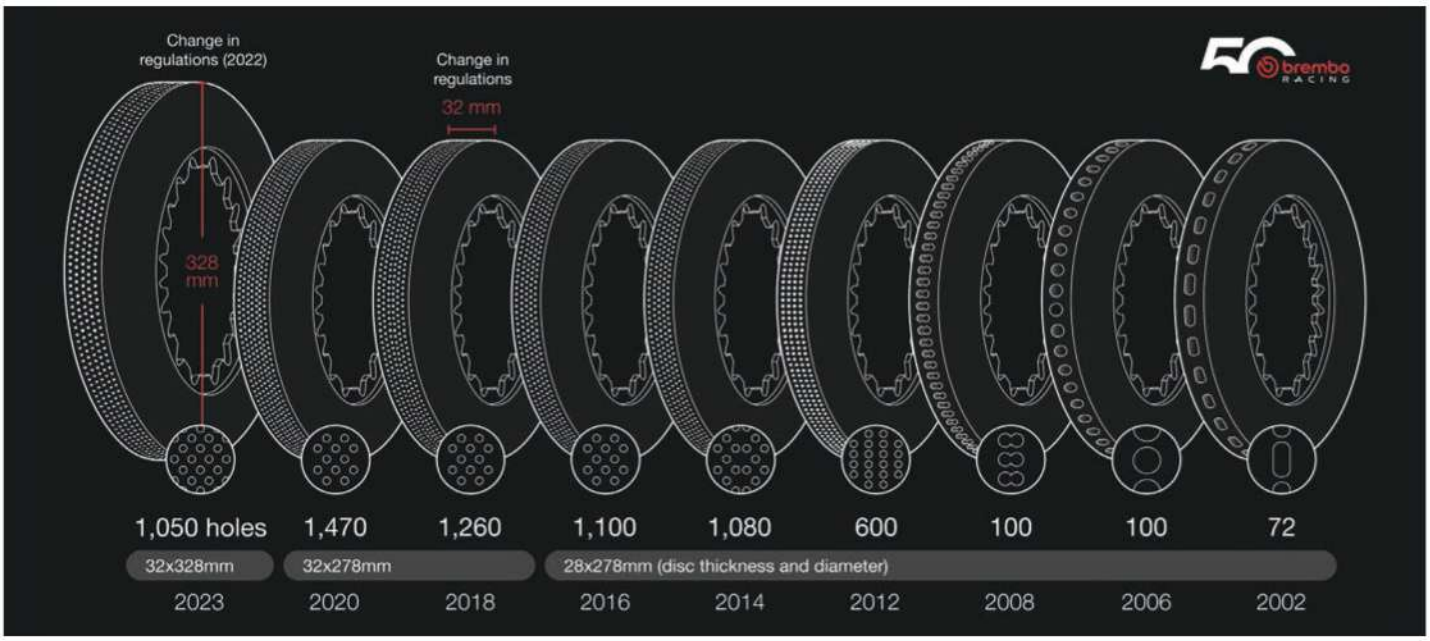
Key players

Brembo is one of the key players in the F1 braking systems market. The Italian company is celebrating its 50th anniversary of F1 involvement this year and currently supplies discs to half the grid, covering Ferrari, Red Bull, Racing Bulls, Sauber and Haas. It also provides calipers to all teams except McLaren, which works with AP Racing.

Brembo has owned Coventry, UK-based AP Racing since 2000, although this doesn't prevent the two brands 'competing' for the same clients. Indeed, McLaren's recent success has prompted interest from other teams in AP Racing's calipers and various other hydraulic components.

Brembo is the busiest of the brake component firms, as it also provides brake-by-wire systems to four teams, although most have chosen to develop their own.

Another prominent company is Safran. The French firm specialises in aircraft landing systems, but also builds F1 brake discs on the side. It currently supplies discs to the FIA Formula 2 Championship (which work in conjunction with Brembo bells and calipers), as well as some Hypercars and the top class in Japanese Super GT. Safran operates in motorsport through its ownership of Carbone Industrie, which has been active in F1 for more than 40 years under different parentage. McLaren, Mercedes, Williams, Aston Martin and Alpine currently use Safran discs. It also previously worked with Racing Bulls, until the Faenza-based team switched to Brembo during the 2024 season.



Evolution of Brembo front brake discs for F1. The 2026 discs are allowed to be a maximum of 34mm wide and 345mm in diameter, with a minimum diameter of 2.5mm for the cooling holes

chief engineer, Angelos Tsiaparas, 'but this doesn't necessarily mean we will downsize the outboard (friction) brakes significantly as there are still scenarios that, for performance reasons, we would trade between outboard and inboard (electronic) braking.'

Woodcock adds: 'It definitely depends on regen' strategy, which I'm sure will develop as teams understand the new PUs. We're hearing different considerations that are needing to be made. Some are saying they're not going to use the rear brakes much, others saying they might need to. It's an interesting time.'

While the rear discs are allowed to be a slightly smaller diameter, they can be up to six per cent thicker, and a thicker disc would enable more cooling holes to be fitted around the rim. Currently, a rear disc contains around 900 holes, and a front disc just over 1000.

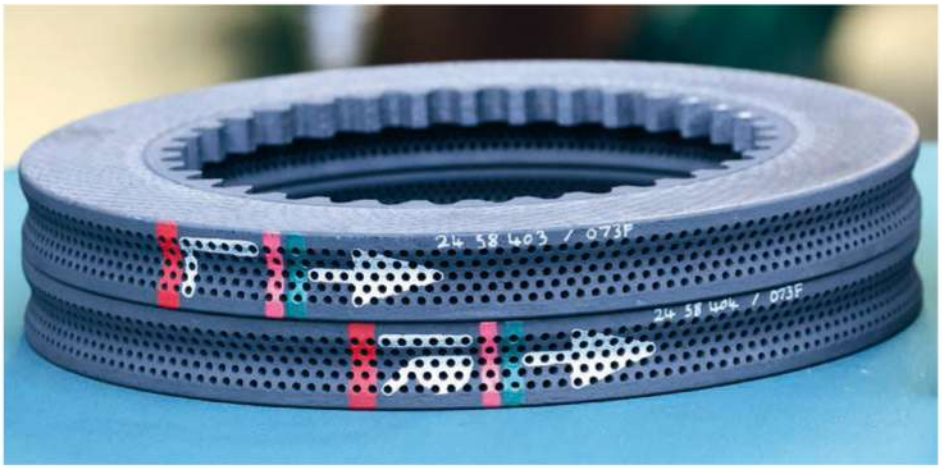
However, extra thickness means extra weight, so teams will be keen to avoid going right up to the new limit. According to Brembo, a rear disc weighs approximately 1.3kg, and a front disc 1.6kg. Given the minimum permitted car mass will reduce by 76kg in 2026, any chance to minimise brake weight gain will be taken.

'Some [teams] are saying they're not going to use the rear brakes much, others saying they might need to. It's an interesting time'

Dan Woodcock, principal design engineer at AP Racing

'It's an interaction between cooling, stress and consumable materials,' says Almondo of the permitted disc thickness going up. 'The objective is two races with the same disc. If you put everything together, including the new expected load on the front axle, this [number] is the result. This is giving us, the FIA and the teams a more tranquil perspective.'

The front braking system will not change as much as the rear. Disc diameter will increase, though the reasoning for this is not clear.



F1 brake discs have over a thousand holes for airflow that facilitates cooling. This Safran disc has a concave rim to save weight

One theory is that the more potent MGU-K requires a re-balancing of the braking capacity of each axle. How much more powerful will the front brakes need to be?

'I wouldn't be very specific on that because we have many balls in the air,' says Almondo. 'but maybe a five per cent more generous system is not far from what we will see.'

The brakes will be acting on a car that uses active aerodynamics (flaps on the front and rear that open on the straights to reduce drag and close for the corners to increase downforce). However, Tsiaparas reckons this won't have a huge impact on the braking phase. He also believes narrower tyres will have 'minimal effect' on braking because they counteract the car's lower downforce levels.

'Active aero will have influence, in terms of how quickly the system moves between straight-line mode to cornering mode and how that interacts with peak braking demands,' notes Tsiaparas, 'but there are regulations around the closing speed, so therefore the influence is likely to be small.'

Mix and match

How the teams will deploy their calipers remains a mystery. With more options available, could they mix and match? Perhaps a team runs four pistons on the rear and eight on the front, squaring the higher MGU-K regeneration with increased front brake demands. Or perhaps they choose six pistons on both ends, sticking with what they know. Williams has indicated that comparing the performance benefits with those of other new components, and balancing that with the available development budget, points towards sticking rather than twisting.

'We have some differences in how the calipers are mounted and how many pads you can have,' says Tombazis. 'They are to

improve the efficiency of the brakes and to enable the teams to reduce weight a bit and reduce installation stiffness. All of that means brakes will be quite a challenging topic.'

Woodcock adds: 'We're not finalising the spec until the summer of 2025, so there is plenty of work going on in the background. Final simulations are running now, and parts are being tested for the finished 2026 spec, though I'm sure there will be some further developments during [next] year. Those teams that potentially get it wrong will be updating their caliper sets, like teams would do after any regulation change. I think there could be a bit of variation.'

Material stasis

Brake materials are not set to change dramatically in 2026. Discs are still made of carbon-carbon, a type of reinforced carbon fibre. Calipers, meanwhile, continue to be made of aluminium, with a tiny percentage of lithium to maintain component strength at higher temperatures. 'The maximum material stiffness the FIA mandates is quite limiting,' says Woodcock. 'It means you can't go too exotic, although we have a number of options. The competitive edge is found in the design methodology and how close you want to run at the limit of stress.'

F1's introduction of a cost cap in 2021 has contributed to a stasis in materials development, for brakes at least. Current materials are strong, reliable, resistant to high temperatures and extremely high performing. Pushing the limits of these characteristics is not always an option when a team only has so much money to spend across a litany of components.

'I do not see, even for the next few years, better materials than carbon-carbon and aluminium-lithium,' says Almondo. 'Maybe you can have some exotic blending of new materials for calipers, but the cost has to make sense. You cannot use something that is costing 10 times more for five per cent more stiffness. Formula 1 is about spending a lot of money, but not 10 times more money, because that is not sustainable.'

Step changes

The 2026 regulations represent arguably the most significant change in F1 brake technology since the start of the hybrid era in 2014. The introduction of hybrid yielded the arrival of regenerative braking and brake-by-wire, making for an altogether more complex rear braking system. There have been other notable tweaks, such as in 2022 when the current cars arrived with larger, 18in diameter wheels that required larger discs. 'It was the first time that brake-by-wire was introduced,' confirms Almondo. 'You needed to blend regenerative braking and dissipative braking. This time [around], we are brake-by-wire experts, but we know less about active aero, narrower tyres and lighter cars.

'Technologically speaking, maybe the jump in 2014 was even higher because brake-by-wire was an unknown. This time, if I would say how easily we reach the limit of performance with the new rules will not be immediate, because understanding how to use active aero, and the new tyres, will require a bit of time.'

From 2026, the brake-by-wire software challenge shifts to making the hardware as compact and light as possible, packaging it within the smaller cars in a way that doesn't compromise aerodynamics.

Brake materials, such as carbon-carbon for the discs and aluminium-lithium for the calipers, have not changed much in recent years as the cost cap dictates where progress and investment are made. It's also a successful combination

Into the unknown

Due to all the regulation changes, F1 has given teams three times more pre-season running than usual in 2026, but it will still be hard for the teams to nail their final designs from the outset.

'For the braking system, we try to specify and size components to cover a wide range of scenarios, which will be refined when we have more mature understanding about the optimal performance window of these new cars,' says Tsiaparas. 'One [challenge will be] the brake system control and interaction with other mechanical systems, such as the gearbox and energy harvesting / management while braking and downshifting.'

The suppliers have also been working on the new cars' requirements. 'There is going to be a sweet spot somewhere,' reckons Oliver Moore, F1 race engineer at AP Racing. 'It's just how many teams will be right and wrong. We want to be in the best position in terms of what we offer to our customers from the information we receive to make sure we come up with the best starting point for 2026.'

'The competitive edge is found in the design methodology and how close you want to run at the limit of stress'

Dan Woodcock, principal design engineer at AP Racing

Testing facilities

F1 teams make a lot of their own components in-house, but also lean on experienced suppliers for other items. F1's current brake suppliers are hugely experienced and have found business with teams up and down the grid. They come with extensive design and test facilities that continue to test the boundaries of brake performance.

Both AP Racing and Brembo have large facilities housing brake dynos where engineers can run calipers, or even an entire corner, through simulated laps of specific F1 tracks. Thermal efficiency has been a key area of focus in recent years, and AP Racing has a heat plate to test parts at high temperatures. A caliper can run comfortably up to 200degC, but needs to operate lower than that to have enough margin for the spikes that occur when running in traffic.

Before a part is produced to run on the dyno, it is designed and tested via simulation. Once the options have been whittled down by a CAD system, more detailed analysis is undertaken using other specific software – one example being Altair HyperMesh – to understand how the part will integrate with a car's complete braking system.

'The teams have equally competent equipment at their factories, but we like to see ourselves as an extension of their design and test resource,' says Oliver Moore, F1 race engineer at AP Racing.

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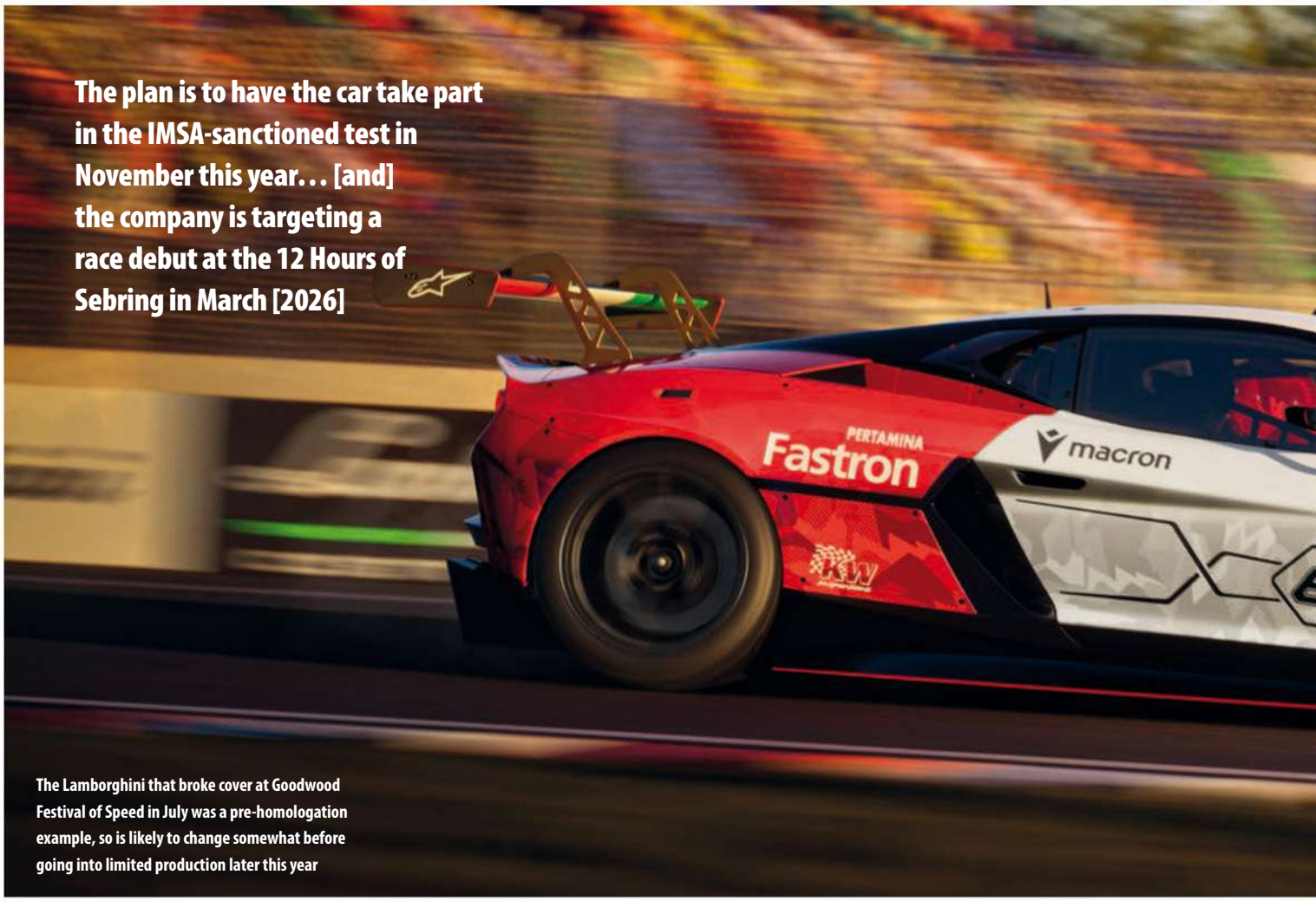
Generation T

Lamborghini has presented its new Temerario GT3, which will replace the aged Huracán and take the company into a new era of customer racing

By ANDREW COTTON



The plan is to have the car take part in the IMSA-sanctioned test in November this year… [and] the company is targeting a race debut at the 12 Hours of Sebring in March [2026]

The Lamborghini that broke cover at Goodwood Festival of Speed in July was a pre-homologation example, so is likely to change somewhat before going into limited production later this year

The new Lamborghini Temerario GT3 was launched at the 2025 Goodwood Festival of Speed in July, just weeks after the car it will replace, the Huracán GT3 EVO2, scored the biggest win of its 10-year career. The Huracán, run by Grasser Racing Team, took victory at the 24 Hours of Spa, ahead of a record field of 74 starters at the Belgian endurance classic. That topped major North American victories at the 24 Hours of Daytona in 2018-2020, the 12 Hours of Sebring in 2018 and 2019 and at Petit Le Mans in 2023 and 2024.

The list of laurels for the outgoing Huracán leaves the Temerario with some big shoes to fill, but Lamborghini insists its replacement is even better. The car has been designed to be more stable in traffic and overtaking, with a turbocharged V8 engine that is less peaky than the 5.2-litre V10 power unit in the Huracán, and easier for teams to work on.

It is, says the company's chief technology officer, Rouven Mohr, a car more appropriate for modern GT racing – which has evolved significantly in the decade since the Huracán first raced – and better able to run with the latest technologies, including torque sensors.

There have been a few technical challenges to be overcome before the Temerario GT3 could finally take to the track. Firstly, removing the hybrid system that is in the roadgoing version, and adapting the drivetrain and cooling systems to run without electric assistance. Secondly, reducing the power from the ICE from 800bhp to the 500-600bhp required by GT3 regulations. Thirdly, modifying the car's aero package to widen its operating window.

The Temerario GT3 was designed and developed throughout 2024 and into 2025, alongside the first season of the troubled Lamborghini SC63 prototype that now looks set not to race next year, unless a team stumps up the money to do so.

Track testing only started in July, and the GT3 car has not yet been homologated, so is still subject to change. When pre-launch interviews took place at Spa in July this year, the car had completed only six days of testing, covering just over 1000km, so there is plenty of work still to do before the car can be homologated, and then raced.

Race target

The plan is to have the car take part in the IMSA-sanctioned test in November this year, though Mohr says competing in the 24 Hours of Daytona in January 2026 is 'unrealistic'. Instead, the company is targeting a race debut at the 12 Hours of Sebring in March.

A maximum of 10 cars will be produced for the track in 2025, though even that is considered an ambitious target as demand for the road car is high. Lamborghini will therefore have to select carefully who will run the car, and where it will compete, before it is made available to a wider audience.

The Temerario is based on the next generation of Lamborghini road car. The production model, which was launched in 2024, was designed with the knowledge that a racing variant would be created from it, so certain decisions were made at the design stage to help with the transition to track.

One of those was carrying over the car's aluminium spaceframe chassis, but with modifications to make it lighter, stiffer and more versatile for the race teams. Detachable front and rear chassis sections have been introduced, similar to the Ferrari 296 GT3, which puts the car more into the realm of a prototype than a GT car. It means repairs following an accident should be easier to manage at the track.

The car's front and rear ends are single pieces of bodywork, again with an eye on speeding up repairs. They're also made from composite material for the first time, further reducing the base weight. This is an upgrade mechanics working on the car will certainly

appreciate, as the Huracán GT3 had individual bodywork sections, more like a regular production car.

The floor comes in four sections, two ahead of the front axle, one through the centre of the car, and the diffuser. The centre section is designed to be changeable on pit road, if necessary, which would save time pushing it into the garage. However, the bodywork parts need to be flush fitting to make this approach successful.

'We get the body in white, make it a bit stiffer and then add the front and rear mounting concepts, as this was foreseen in the road car [design],' confirms Mohr. 'It was clear the road car would have a brother, or sister, that would race so, when we designed the road car, we already considered the right interface point for repair.'

Increased options

The new model features a longer wheelbase than the Huracán, and a wider track front and rear. It retains the production Temerario's hydraulic steering rack but, for the first time, features six-way dampers from KW Automotive, increasing the number of set-up options for teams and bringing the car further into line with its competitors. The suspension is no longer mounted using carbon inserts into

Unlike the outgoing Huracán, the bodywork of the Temerario is made from composite in larger sections to make life easier for teams working on the car

The racecar has many carryovers from the high-performance road car it is based on, including the aluminium spaceframe chassis, albeit modified for extra stiffness

the chassis, but instead via plates, with speed of change in mind, but also to try and reduce the affected area following an accident.

'This is not rocket science,' says Mohr of the switch to KW dampers and the increased set-up adjustability. 'The cars presented in the last few years have six-way, and the customers have the set-up options and the drivers have the driver feeling. With the current [Huracán], the gentleman drivers [have a harder time] than the professionals. The car is agile and rotates a lot, and you have to work hard on the brakes, so when you turn in you cannot over run the front axle too much. A pro driver is happy with this because he can position the car, but the gentleman driver sometimes has difficulty with driveability.'

The new suspension is designed to work with the variety of tyres currently available to GT3 racing, including Pirelli in the GT World Challenge, Goodyear in the FIA World Endurance Championship (if the car returns to the series) and Michelin in the IMSA SportsCar Championship in the US.

Despite the Huracán's many successes on track, it still suffered a few shortcomings, notably on the aerodynamic front. Indeed, one of the car's main drawbacks was its reduced ability to move out of the slipstream and overtake another car. There were a few different reasons for this, as Mohr explains: 'The Huracán is good on the brakes, good rotation in, fast rotation in, so always good in the corners. The disadvantage is its raceability, with the normally aspirated engine and the airbox on the roof that we introduced on the EVO2 concept. In the slipstream it is okay but, when you go out of the slipstream, there is less possibility to manage the torque in the right way. The driver has to be very precise with the shifting point. If they are not 100 per cent, then the driver struggles. This is removed in the new car, as with the turbo you have more opportunities with boost management.'

Notably in the Temerario, the air intakes for engine, brake and oil cooling are all now in the side, behind the doors.

The team has also worked hard to widen the car's operating window as much as possible. Where the Huracán needed precise ride height settings to be quick, the Temerario should be more forgiving. 'You try to combine the elements to be as robust as possible with ride height sensitivities and slipstreaming,' continues Mohr. 'The Huracán is super fast in clear air, but the set-up window is very narrow, so to find the sweet spot you need to know the car really well. It is fine tuning but, for sure, this car will be more robust on aero, power delivery and set-up.'

In-house power

The engine in the Temerario GT3 is a completely new design. Where the Huracán relied on a 5.2-litre V10 derived from the Audi R8 LMS GT3 power unit, the new car has an in-house designed 4.0-litre, twin-turbo V8. The engine has been tuned to deliver its power across a broader rev range, which will help teams that race in series using torque sensors as it will be more versatile in tuning.

Where the Huracán relied on a 5.2-litre V10 derived from the Audi R8 LMS GT3 power unit, the new car has an in-house designed 4.0-litre, twin-turbo V8

Again, the road car engine was designed in the knowledge that a racing version would be produced. So, it features a flat-plane crank with a 180-degree angle between the crank pins, as well as titanium connecting rods for weight saving. The biggest change is to the size of the turbos. Having dispensed with the hybrid system, the team then had to de-tune the engine from 800bhp to less than 600 to fit with GT3's BoP criteria. It did that primarily by reducing the size of the Borg Warner turbochargers.

'The race engine revs to 10,000rpm, but in racing we operate at between 500 and 600bhp [so don't need the high engine speed],' says Mohr. 'So you can imagine there is a lot of downsizing, but the pistons, rods, engine block, camshafts… everything is one to one with the road car. Only [the] turbocharger [has] changed, and [hybrid] electrification is out. Then, based on the different turbo and cooling concept, we have an air-to-air cooling system, while in the road car it is water-to-air.

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Competition dampers

KW Automotive launched its new KW V7 racing damper at the Goodwood Festival of Speed in the UK in July. This is the damper fitted to the Lamborghini Temerario GT3, which was also unveiled at the event, and is also found on other models competing in the same category, including the Porsche 911 GT3 R.

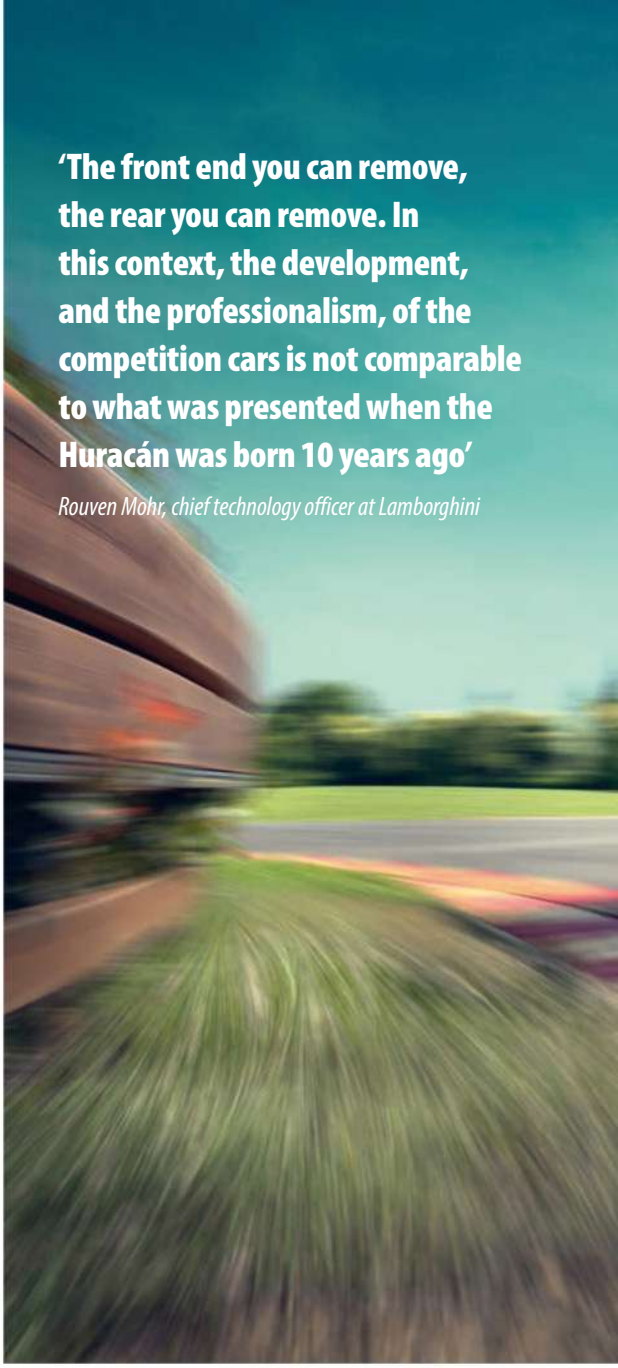
The damper is developed specifically for GT3 class cars, and is based on KW's solid piston technology, in which the valves are separated from the piston. The working piston displaces the hydraulic column towards the valves, allowing for significantly higher forces to be generated at low gas pressure, while the offset and flow-optimised valves ensure cavitation-free operation and enable the entire system to function with minimal hysteresis.

The dampers cover a wide range of force characteristics between 1000 and 12,000N and are said to operate with precision even in situations with minimal suspension travel and high aerodynamic loads. Depending on the BoP figures, current GT3 vehicles generate around 900kg of downforce at top speed on the Döttinger Höhe section of the Nürburgring Nordschleife, equivalent to more than two thirds of a GT3 vehicle's total weight.

The valves are adjustable in high-speed and low-speed compression, as well as high-speed and low-speed rebound. Additionally, the V7 racing damper features a blow-off adjustment for both compression and rebound, allowing for a flatter force curve in the high-speed range. This provides the advantage of maintaining vehicle control even when aggressively cutting kerbs during a race.

The KW V7 racing damper is manufactured from high-strength aluminium alloy and features shim inserts that allow the ride height to be levelled without affecting suspension travel through the spring perch during height adjustment.

KW's new V7 racing damper is standard fitment on the Lamborghini Temerario GT3, as well as some of its rivals, such as the Porsche 911 GT3 R



'The front end you can remove, the rear you can remove. In this context, the development, and the professionalism, of the competition cars is not comparable to what was presented when the Huracán was born 10 years ago'

Rouven Mohr, chief technology officer at Lamborghini

Aerodynamic sensitivity has been reduced and further work is to be done to improve slipstreaming to present a more balanced racecar

'This is because the road car has a more sophisticated overall cooling system due to the hybrid. In the road car, there are five different cooling circuits talking to each other, here it is much easier.'

Power is delivered to the wheels via a six-speed gearbox from Hör Technologie, replacing the road car's eight-speed unit. Another change from the Huracán sees the gearbox mounted transversely, rather than longitudinally, opening up some additional space for the rear diffuser.

Balanced flow

Generating much of the downforce from the underbody was one of the main targets for the car, and then balancing that with the air flowing over the body. There is, says Lamborghini, not much point in having one without the other if you seek a well-balanced racecar.

While the Huracán was effective, it was also very sensitive in terms of overall set-up, so a lot of work has gone in to make the Temerario easier to generate lap time with, largely by reducing overall sensitivity.

The team will undertake slipstreaming work in August, as it is not possible to do that in the wind tunnel, and expect further changes to be made to the nose of the car, including the dive planes that were on the presentation model.

'The front splitter gives you different adjustment opportunities, which is good, but has led our customer teams into difficulties,' admits Mohr. 'Our [Huracán], if it's not in the perfect window, with splitter and ride height configuration, you lose the peak performance window. The new Temerario is more robust.

'The front end you can remove, the rear you can remove. In this context, the development, and the professionalism, of the competition cars is not comparable to what was presented when the Huracán was born 10 years ago. We have the latest repair options, and a car that is easier for customer teams to operate in a more robust window.'

The car is fitted with a new refuelling system that allows for quicker flow but, importantly, also features new, more accurate sensors that deliver better information on remaining fuel back to the pit.

The cabin has been designed with the non-professional customer driver in mind, with updated switches, graphics and a steering wheel based on feedback from both professional and customer drivers. Visibility has also been improved over the Huracán which was, admits Lamborghini, a little claustrophobic with its low roof line and double a-pillar in the line of sight.

The Temerario GT3 is the first racecar designed, developed and built at Lamborghini's factory in Sant'Agata Bolognese. It will be run by customer teams as part of the manufacturer's Squadra Corse framework and, if the SC63 does not return to action, is poised to spearhead the Italian constructor's racing activities for years to come. There is a great deal riding on the success of this car.

Gin and juice

Ginetta has committed to SRO GT2, and hopes it can help spur renewed interest in the category

By DANIEL LLOYD

What springs to mind when you read the term GT2? If you followed motorsport in the late 2000s, you might instinctively think of the class that raced at the 24 Hours of Le Mans. Conversely, you might know GT2 as a recent phenomenon; a category created by SRO Motorsports Group that runs on the GT World Challenge Europe support bill. Both interpretations would be valid, though only one is currently active.

The SRO GT2 formula, of no technical relation to its extinct namesake, was launched just before the Covid pandemic and had its first season as part of the GT2 European Series in 2021. Now in its fifth campaign, it has just attracted a new manufacturer in Ginetta. This has been welcome news for the SRO's boss, Stéphane Ratel, who has seen his GT2 grids struggle to sustain numbers above mid-teens.

Stepping up

UK-based Ginetta is well known in motorsport for its young driver development pathway, but has also taken on more wealthy amateurs in recent years. The latter had originally been the main target market for GT2, which, somewhat confusingly, sits below GT3 in the SRO hierarchy. Its cars are more powerful than GT3s, but generate less downforce. Once almost exclusively the domain of rich businessmen, the GT2 European Series will next year allow FIA Silver-graded driver pairings to compete (in other words, young drivers wanting to train for GT3). Ginetta therefore thinks now is the right time to enter GT2, as the category's ethos shifts and covers its entire customer base.

'It's going to be an amazing step up for a GT4 racer,' says Mike Simpson, CEO at Ginetta Motorsport. 'Stéphane has listened. It's not just a boys' club, he sees it as a direct promotion into GT3. How can we use GT2 as a feeder into that? Embrace the Silver driver and the Pro, who might have an Am who can buy a car and make a programme happen, and maybe do GT3 the year after. GT2 has been put out as a bit of a halo project [but] the GT4 to GT3 transition is huge, in terms of lap time, speed and engineering capability. I think GT2 has firmly aligned itself in the middle.'

'The GT4 to GT3 transition is huge, in terms of lap time, speed and engineering capability. I think GT2 has firmly aligned itself in the middle'

Mike Simpson, CEO at Ginetta Motorsport

In 2026, a funded GT World Challenge Europe Endurance Cup drive will be awarded to the best performing driver in Maserati or Mercedes-AMG GT2 machinery

A new Silver Cup class will be added to GT2 next year, which could play to Ginetta's well-founded reputation as a starting point for budding sportscar drivers with their sights set on GT3 action

Ginetta's carbon chassis G56 forms the basis for the company's latest foray into European GT racing. The aim is to offer a versatile package that can handle different BoP values

Ginetta unveiled its GT2 car at the SRO's headline event, the 24 Hours of Spa, in late June. At time of writing, the company is hoping to run it in the GT2 European Series round at Valencia in September, while customers will be able to use it from 2026.

G56 baseline

The Ginetta GT2 is derived from the G56, a Ginetta racecar that has been developed into different iterations. One of those is a GT4 variant, which made its debut in 2021 and received an Evo update in 2024. The GT4 is important because, like the GT2, it races in an SRO-sanctioned series that uses a BoP system to achieve parity between different car makes. The primary aim for Ginetta with its GT2 was to have a versatile design that could handle different weight and power values from the BoP without compromising driver confidence. The carbon chassis of the G56 is known to afford that versatility, so was a logical choice as the basis for the GT2.

'That chassis has stood the test of time, and the iterations have provided us with a big wealth of versatility in ride height and engine performance,' says Clive Seddon, technical director at Ginetta Cars. 'We don't want to lose that, because when we go into doing GT2, there will be BoP at play.'

The G56 GT4 Evo has run as heavy as 1500kg this season, but the GT2 that was unveiled at Spa, using the same chassis, weighed only 1220kg. Ginetta expects that figure to rise because it is targeting a power-to-weight ratio of 2:1 and GT2 cars typically race at about 650bhp. It also expects the BoP to demand a higher minimum weight; Seddon reckons the car will run comfortably up to 1375kg. However, the additional weight that will be added to the launch car to reach that raceable weight isn't going to come from simply adding ballast.

'That chassis has stood the test of time, and the iterations have provided us with a big wealth of versatility in ride height and engine performance'

Clive Seddon, technical director at Ginetta Cars

'We would do what we did with the GT4, which was looking for double wins,' notes Seddon. 'For example, you would add the weight by putting in stainless steel floors instead of aluminium. We put weight either into safety, reliability or ease of maintenance. That parts bin of knowledge is all in the GT4.'

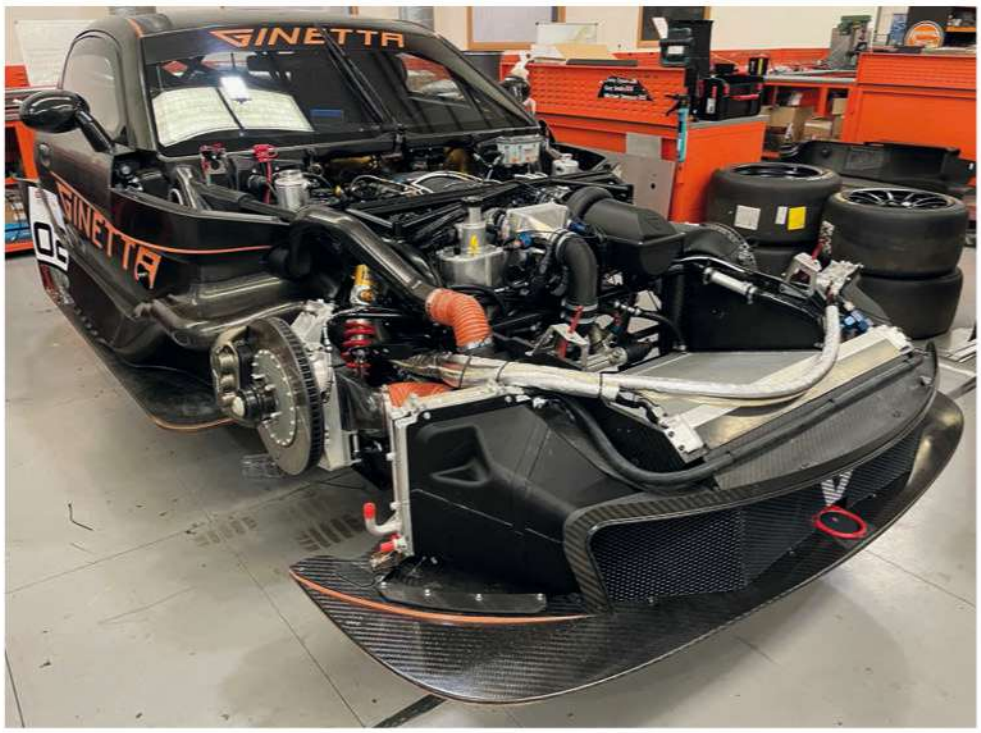
Only minor modifications were made to the chassis for new suspension kinematics and mountings, as well as a new seat and pedal box configuration.

'We're going to the latest regulation seat,' confirms Seddon. 'It has to be fixed in six points, not on rails or four points on the floor. You've got a back mount near where the seatbelts go through. Fixing the seat means the pedal box has to move. On the G56, the pedals and the structure were the chassis itself, the pivots were all in the chassis, so going to an adjustable pedal box was a big iteration for us.'

Power in hand

On paper, the Ginetta GT2 and GT4 might appear to have near-identical powertrains, with the former using a 6.3-litre V8 and the latter using a 6.2-litre V8. Indeed, they share the pushrod V8 with dry sump configuration

Where the engine in the GT4 version is normally aspirated, the GT2 is supercharged to generate more power without sacrificing reliability



Ginetta retained its familiar pushrod V8 approach, but replaced the GM LS2 block with an in-house billet version and added a centrifugal supercharger to increase power without the additional weight and cooling issues twin turbos would have brought

that Ginetta has become adept at tuning. However, where the engine in the GT4 version is normally aspirated, the GT2 is supercharged to generate more power without sacrificing reliability.

The GT4 engine can produce around 500bhp without BoP restrictions but the GT2 will be producing around 150bhp more. It has even touched 800bhp on the dyno at 0.9bar boost pressure, albeit with the caveat of very high fuel consumption.

'To add two quite large turbos, you'd be adding some 30kg of stuff in terms of oil returns, cooling etc,' says Seddon. 'It wasn't friendly for aero because the turbos would have had to go behind the front wheels. That was an area we wanted to clear out, not make worse, so supercharging was a very obvious choice in the end.'

Ginetta opted for a centrifugal supercharger, chosen because it gave more freedom in charge air cooling circuit design. Supercharging an already large capacity V8 brought the challenge of needing to generate less than a bar of positive pressure at a very high cfm flow rate.

'That's a very different challenge to a medium or small capacity engine,' says Seddon. 'The supercharger has to be quite large. That was an immediate challenge, but actually everything fell in our favour because we could keep our intake volume very low. The flow area on the air side of the water-to-air charge cooler is huge, but the water side is very small, because we were only trying to get rid of 40-50degC of air temperature. We're very low pressure, very high flow, so we don't generate a lot of heat. Things we thought might be a challenge actually ended up being our friends, though we still had to get the design right.'

Ginetta's engineers therefore sought a boost pressure ratio that would give the desired power output, while not over stressing the cooling system.

Power goes to the wheels through an Xtrac six-speed transaxle from Ginetta's LMP3 cars, but with wider, 20mm gears, plus custom ratios and differential settings.

The G56 GT4 Evo uses a General Motors LS3 cylinder block. In the GT2, that has been swapped for a billet block produced in-house at Ginetta. The target is for each engine to run for 100 hours before a rebuild; that's a very long time considering GT2 rounds consist of two 60-minute races.

'We wanted to keep the reliability [the LS3 has provided] so we knew we had to go to a different block,' explains Seddon. 'The block in the car at Spa was our own billet. Whether that stands the test of time in terms of being the sensible solution, we're not 100 per cent sure at the minute, but that's what the car is using for all its development.'

Meaner look

From the outside, the most distinctive feature of the Ginetta GT2 is its front end. While the G56 GT4 had a more abrupt drop from the bonnet to the splitter, the GT2's nose slopes down. This has pushed the frontal radiator

The GT2's wheels are the same diameter as the GT4, but wider by one inch at the front and two at the rear. Brakes are Alcon 380mm discs with six-piston front calipers and four piston rears

Engine settings are managed by a MoTeC M150 ECU. Bosch provides the ABS and Sachs supplies the triple-plate clutch with quad option

inlet to the bottom of the nose, making the GT2 car look meaner than the GT4, with its smiley façade. The wheelarches are now flatter and contain louvres. The radiator inlet is also smaller, reducing drag at the expense of less air being drawn in for engine cooling.

'The GT4 car is particularly draggy,' acknowledges Seddon. 'We needed to fix that. We did take the penalty on the cooling entry size; it is much lower, going right down to the splitter. The radiator exits – and that is now plural – give us back the pressure differential that we need. Our exits are now giving us around 30-35 per cent more airflow through all of the cooling package.'

The PWR radiators were made thinner to carry less water, but given more surface area, and complemented with auxiliary radiators each side. Speeding up water flow has helped with the cooling.

The new splitter is part of a front impact structure made by ARS in Italy and tested to 450kg load using finite element analysis.

'Before, we had extra framing in there for steelwork, fabricated tinware for the radiator,' says Seddon. 'It was just more added parts. We went clean slate and started again from the chassis forward. That opened up a lot of opportunity for us.'

Added downforce

Downforce has been added at both ends, with particular attention paid to the rear wing, which has been lifted from Ginetta's LMP3 car, and the diffuser. Focus has also been on reducing drag from behind the rear wheels. On G56 iterations, the area behind the front wheel was 'cluttered' with various hydraulic components.

'Behind the rear wheel was fairly parachuty on the original rear bumper,' says Seddon. 'In conjunction with the diffuser, quite a bit of work has been done. There is still a nod to the original styling with the rear lights, but you'll also see the clear out of a lot of the bodywork.'

A huge rear wing from Ginetta's LMP3 car helps to raise downforce, while drag has been reduced in the area behind the rear wheels

The Ginetta GT2 has been in development for more than a year now. A normally aspirated prototype version dubbed the GTX contested the 24 Hours of Dubai in January 2024, as well as a guest entry into a GT2 series round. In Dubai, Ginetta's engineers and drivers learned that the larger tyres and stronger brakes (to slow a more powerful car) caused excessive movement. This prompted them to build anti-dive and anti-squat into the GT2 car's suspension (Ginetta racecars typically don't have this because they are designed to give an exaggerated action so young drivers learn about vehicle dynamics). However, it was required on the higher-spec GT2, partly to prevent splitter damage. The GT2 suspension comprises double wishbones with spherical bearings, three-way mountings and LMP3-grade billet aluminium uprights, as well as Öhlins TTX40 dampers.

When Ginetta revealed the GT2 at Spa, it was yet to undergo track testing. That will take place over the second half of 2025, leading into homologation and the build of an initial seven-car batch for delivery to customers by Christmas.

There is still work to be done, such as finalising the airbox design. Ginetta has designed and produced most of the parts in-house, using additive manufacturing (AM) to quickly and cheaply create more components with each vehicle it releases. A carbon brake duct inner surface, for example, might cost over £5000 to source externally, but with AM the cost per unit evaporates.

Coming to cost, the Ginetta GT2 is priced at £325,000 (approx. $440,000), just under that of a new G56 GT4 Evo. However, it is significantly lighter and more powerful, so could be a more attractive stepping stone to GT3 from a driving perspective. One of GT2's problems has been that too many cars have been used for track days, rather than appearing on SRO race grids. Simpson hopes Ginetta won't contribute to that trend.

'A lot of [GT2] cars get purchased that do nothing,' he says. 'This would be a disaster for Ginetta. We don't make thousands of these cars, and we need them to run, because we make our living out of servicing components and selling parts. A warehouse full of sold racecars is good for year one, but not year two.'

Ginetta is set to join a grid that currently features Audi, KTM, Lamborghini, Maserati and Mercedes-AMG. Porsche and Brabham previously ran in the European series but have dropped away. GT2 has also been exported to the United States and Ginetta hopes its presence there with the G56 can lead to some sales of its new, more powerful model. If successful, the initial run of seven cars might need to be rapidly expanded.

'We have customers enquiring already,' says Simpson enthusiastically. 'We will help SRO to grow the grid.'

Extreme Evo

Ferrari took the wraps off its new 296 GT3 Evo at Spa, and immediately the car drew comparisons to the now-defunct GTE machine

By ANDREW COTTON

Ferrari has high expectations of its new 296 GT3 Evo, which was launched at the 24 Hours of Spa and has clearly taken inspiration from a couple of the Italian company's more recent GT projects. Just shy of 200 of the original 296 GT3s have been sold, many of them for competition, while others have gone to museums and collections. Regardless, this is possibly Ferrari's most successful race programme.

The Ferrari GT3 project has undergone significant changes in the last 10 years. Italian company, Michelotto, was replaced by ORECA for the 296 programme, and the French company has had its hands full meeting demand since it first started to build the cars three years ago, for delivery in 2023. Design and development was handled from Maranello, in association with ORECA in Signes, France, and the new Ferrari has achieved pretty much all targets set to date. Victories at the Nürburgring 24 Hours, the 24 Hours of Daytona and drivers' and teams' titles in the GT World Challenge Europe series have all been achieved.

However, when the original 296 GT3 was presented at Spa in 2022, it was already controversial. The car went to the absolute limit of new regulations published by the FIA, after consultation with the manufacturers. The rules allowed for a supercar such as the 296 to be built pretty much to prototype specification, and Ferrari went all out from the start.

In the past, cars such as the Ferrari 488 GT3 were not allowed as many modifications as, say, a Nissan GTR. Under the new regulations, a technical rule book was created by the FIA and all cars were built to the same regulations.

Head turner

So, unsurprisingly, when the wraps came off the revised Evo version at Spa in June 2025, all eyes were on it. Resplendent in eye-catching yellow, similar to the 24 Hours of Le Mans-winning AF Corse Ferrari 499P, the new model had clearly taken learnings from the LMGT3 version of the 296 GT3 that races in the FIA World Endurance Championship, and from the GTE car that delivered numerous race wins and titles before that category collapsed.

Notable features include large dive planes and an improved splitter…

From the front of the car to the back there have been huge modifications, including the aero, cooling, brakes and suspension. Even the mirrors and rear wing are taken from the LMGT3 car, but it has not yet been homologated, and so Ferrari was careful to point out that certain elements of the presented car might not make it through to the final spec that will debut at Daytona in January 2026.

From the front of the car to the back there have been huge modifications, including the aero, cooling, brakes and suspension

Rear wing on the launch version is carried over from the LMGT3 racer

…that directs air under the car to the heavily modified rear diffuser

Airflow over the bodywork has been tidied up significantly, to make the car more predictable and easier to drive for the non-professional

The Evo retains the detachable front and rear subframes, allowing for improved access to the chassis and engine, which is unchanged from the original. Other manufacturers have now started to follow that path, so it was only natural for Ferrari to stay on course.

One area of concern in the original 296 GT3 was front brake temperature, and aerodynamic stability when following in traffic, both of which are said to have been addressed in the Evo model.

The front of the car is the obvious place to start when looking at the changes. The dive planes at the front are significant in size, and work has been done to improve splitter efficiency and direct more air under the car to the heavily modified diffuser.

The intake system through the bonnet has been improved, with NACA ducts feeding more air into a new, front-mounted radiator. Airflow to the front brakes has been increased by 20 per cent, according to Ferrari, and that additional air needs to be evacuated, hence the large louvres over the front wheelarches. Part of the job of these louvres is to direct air away from the engine intake at the rear, which was an area of concern on the previous model.

Stable platform

Airflow over the bodywork has been tidied up significantly, to make the car more predictable and easier to drive for the non-professional. Indeed, most of the aero work has gone into making the car stable while following in another car's wake. It has done so by drawing air in from the side, as well as over the front. 'It's not that you are losing the front downforce because you arrive in the vortex of the car in front,' says Bénédicte Prioul, vehicle control engineer at Ferrari Competizione GT. 'It's the way that you manage the vortex of the car in front. It will happen less than before, so you maintain the vertical load even when you are approaching another car by taking [air] in from the side.'

Another beneficiary of the increased cooling at the front is the hydraulic power steering system, which is adapted from the original version of the car. This was not enough of a concern to warrant a switch to electronic power steering, it just needed extra cooling at certain races, which the new aero package is said to deliver.

The rear wheelarch and rear wing are taken directly from the LMGT3 version, with a more aggressive vertical section of the wheelarch, which will make it easier for the car to take other makes of tyre. The rear wing end plates are rather bigger than might be expected, and this is an area Ferrari believes might change for the homologated machine.

Under the rear wing is probably the most significant difference. The strakes in the diffuser have been drastically altered; made deeper to provide more downforce, while also mounted so they can be changed when required. 'The volume of air in the diffuser is different, as are the number of fences [strakes],' says Prioul. 'The profile of them is completely different, and you can change them individually as well, so we can direct the air correctly and maintain the downforce. This was part of the feedback from customers; they wanted

Ferrari was at pains at the launch to point out that this is a pre-homologation example, so some of its more dramatic aerodynamic features may not make it through to the production version

Under the skin, there have been subtle changes made to the suspension kinematics in an effort to make the 296 Evo a more balanced racecar

to be able to dismount and change them when you have wear on these parts.'

The mirrors are also striking in their presence, taken from the LMGT3 and modified, taking into account the frequencies and modes of vibration the car is expected to see. They have also been pulled inwards to improve visibility.

Under the skin, the suspension kinematics have been changed front and rear, with the aim of reducing the load on components to improve reliability. The relationship between the front and rear axles has also been modified, reducing pitch sensitivity and ensuring a more balanced car.

The new car will be available to customers from 2026, ideally in time for an entry in the 24 Hours of Daytona

Price point

Two burning questions were asked at the launch: the price of the update kit for existing 296 GT3 customers, and the price of a new car. Ferrari remained tight lipped about both, mainly as the car has not yet been homologated, though the manufacturer is expecting the Evo to be a similar price to the original, so around €650,000 (approx. $761,100) plus tax, and the kit to be around €100,000 (approx. $117,000). There is, says the team, no reason to increase the cost just because the parts are new.

If this is the case, it makes the 296 GT3 Evo significantly cheaper than some of its rivals, such as the Ford Mustang GT3 and Chevrolet Corvette Z06 GT3.R, which are pushing close to the €1m mark. The Evo kit on its own is understood to be more affordable than many of its rivals.

The Evo will be available to customers for the 2026 season, and the team hopes it will be in their hands for the 24 Hours of Daytona. It is a significant upgrade to an already successful car, even within the Balance of Performance parameters, but it still has one job to fulfil that its predecessor failed – to win its class at Le Mans. At least it's painted the right colour to try. R

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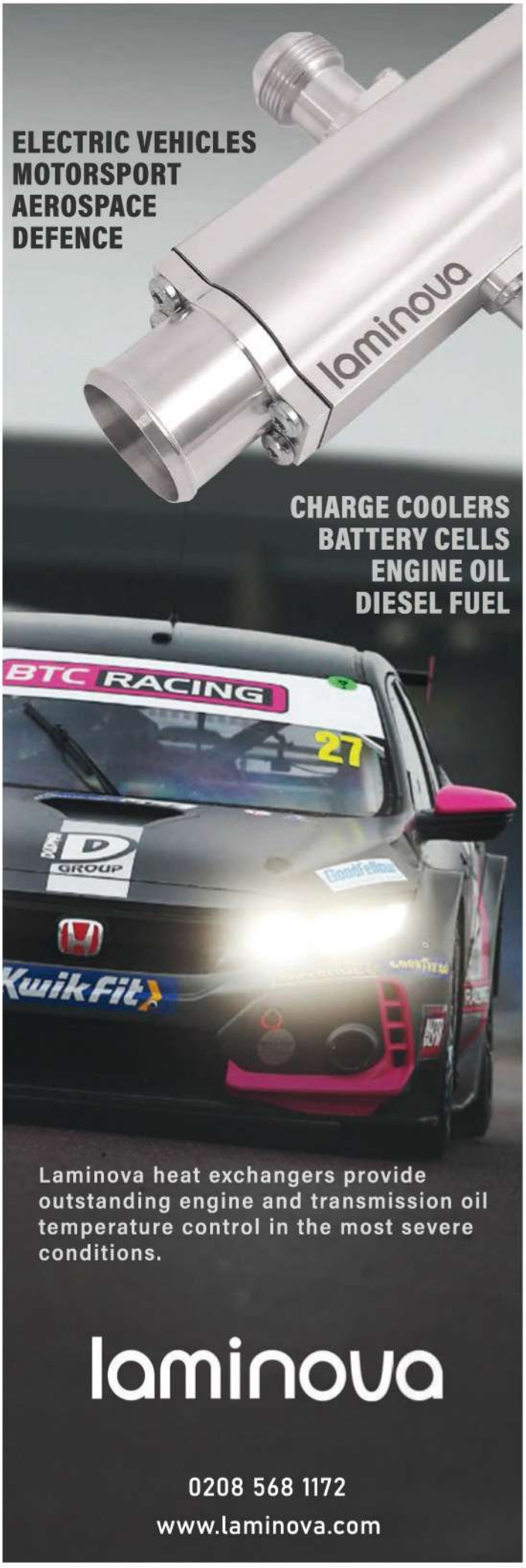
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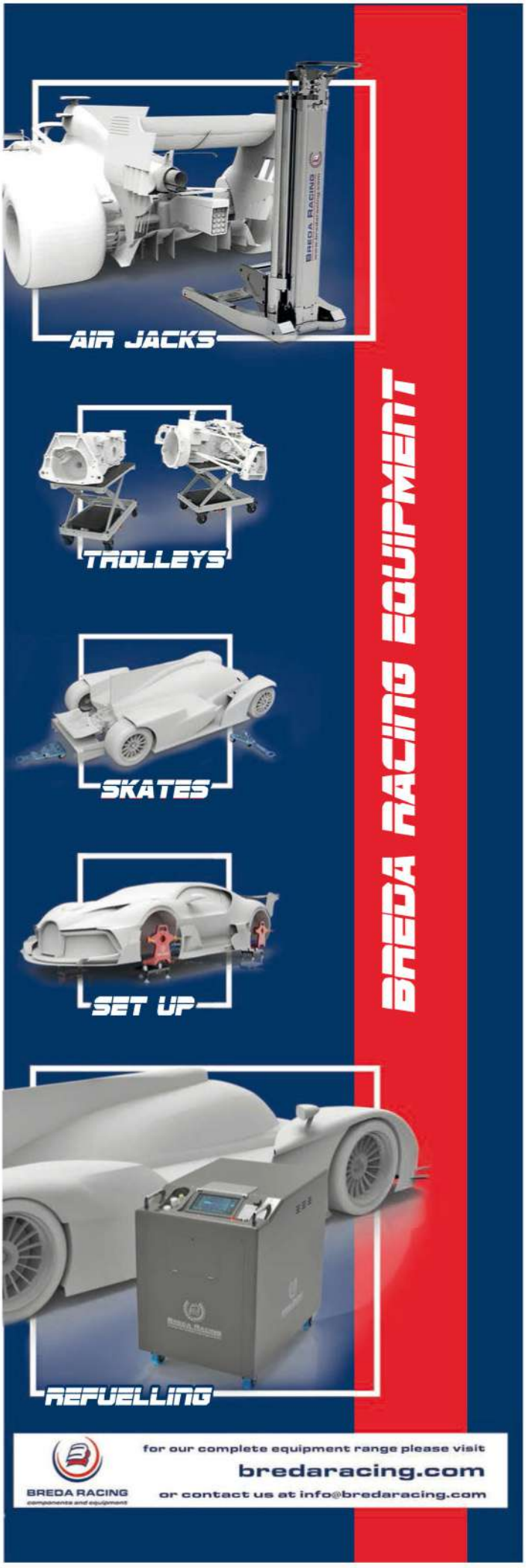
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Basque in glory

A team from the Basque Country led a one-two-three for EVs in the latest edition of Formula Student UK

By DANIEL LLOYD

The 2024 edition of Formula Student UK was a one-horse race in favour of Edith Cowan University from Australia, which won by more than 200 points and was the only team to exceed 800 points. Twelve months later, five teams exceeded that figure, suggesting the overall level had been raised in terms of design competence and preparation. Indeed, 41 per cent of the 59 cars taking part made it on track after passing scrutineering, compared with 36 per cent last year. Eleven cars tackled every track event, up from seven, while the average total score across the top 10 teams increased by 160 points. The impression from walking the paddock was that more teams were better prepared and had carried out multi-faceted validation programmes including FEA, CFD and track testing.

Electric generation

The 2025 winning car came from the University of the Basque Country near Bilbao in northern Spain. The team was the second highest scorer across the four static disciplines and carried that form into the dynamic events, setting the fastest Skid Pad time, finishing second in Acceleration and taking third in Endurance, the highest paying category. This enabled the Basque team to win by 82.1 points from the Technical University of Denmark (DTU), a surprise runner-up considering this was the first time its car had passed scrutineering. DTU topped the static table, but wasn't quite fast enough on track to contend for outright honours. Third went to Oxford Brookes University, a team that has finished on the podium several times but not yet tasted overall victory.

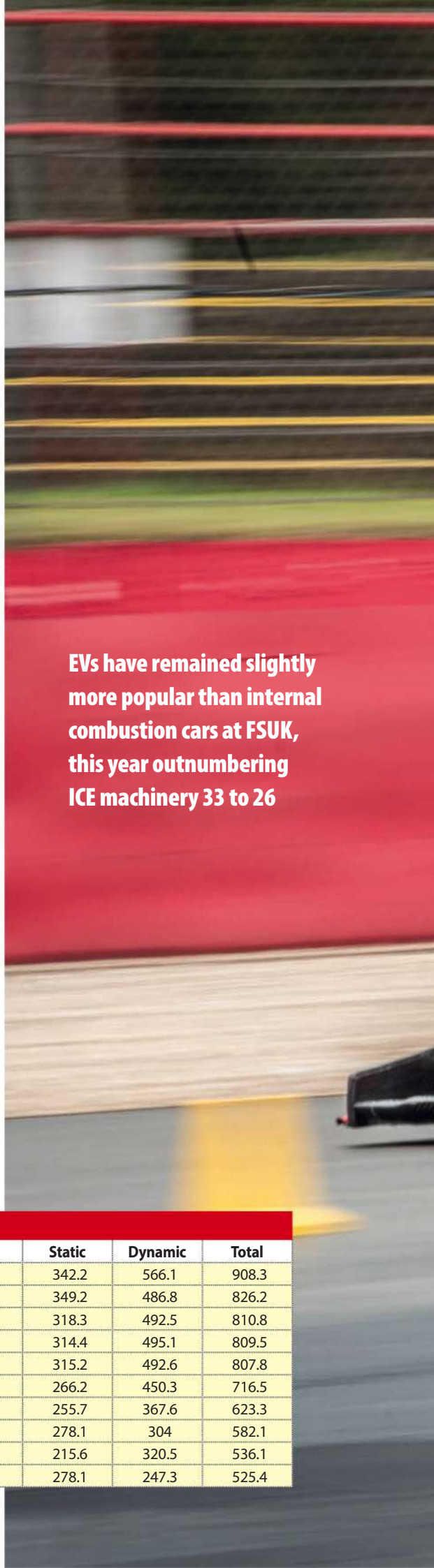
The top three teams all brought electric-powered cars to the competition at Silverstone. EVs have remained slightly more popular than internal combustion cars at FSUK, this year outnumbering ICE machinery 33 to 26. For the first time, all ICEs had to use biofuel from Sustain Fuels, choosing between 82 per cent and 10 per cent ethanol blends.

The electric front runners all brought car designs that built on concepts from 2024, rather than making drastic changes. While Formula Student rules require each successfully scrutineered chassis to be replaced, there is nothing to stop ideas being passed from one edition to the next, and between successive generations of students.

The Basque Country and Oxford Brookes both utilised all-wheel drive systems, a design choice that paid dividends when rain fell over the two days of dynamic events.

'We improved the control of our car through the torque vectoring control. It controls each wheel independently,' explains Eduardo Garcia, team leader at University of the Basque Country. 'We have tried to improve our speed in Acceleration and Skid Pad, so we can adapt our car to the different dynamic events. We divide the torque vectoring into 10 levels and adjusted these levels according to the weather and track conditions. We also changed the suspension with new dampers.'

The Basque car, developed by a team of 55 students and four faculty advisors, featured a Fischer Elektromotieren TI085 motor in each



Steve Miles / IMechE

EVs have remained slightly more popular than internal combustion cars at FSUK, this year outnumbering ICE machinery 33 to 26

Formula Student UK 2025 results

	Team (power source)	Static	Dynamic	Total
1	University of the Basque Country (EV)	342.2	566.1	908.3
2	Technical University of Denmark (EV)	349.2	486.8	826.2
3	Oxford Brookes University (EV)	318.3	492.5	810.8
4	Staffordshire University (ICE)	314.4	495.1	809.5
5	University of Birmingham (EV)	315.2	492.6	807.8
6	Imperial College London (ICE)	266.2	450.3	716.5
7	University of Agder (EV)	255.7	367.6	623.3
8	Sheffield Hallam University (ICE)	278.1	304	582.1
9	University of Malta (EV)	215.6	320.5	536.1
10	University of Southampton (EV)	278.1	247.3	525.4

The University of the Basque Country team said it conducted 200km of testing in preparation for FSUK, starting that part of its validation programme in mid-April

wheel, and a 600V battery module comprising six Melasta cell packs. The total battery capacity was therefore 7.2kWh, and the team developed regenerative braking to ensure its drivers could push throughout the Endurance event. At 249.5kg, the car was on the heavier side, mainly due to the combination of a weighty EV powertrain and a substantial aerodynamic package. To offset some of that, it also featured a carbon fibre monocoque and a decoupled suspension design, using air springs to enable independent movement.

Oxford Brookes put much of its energy into weight saving and came in lighter than the Basque Country car at 223kg. Teams from Brookes have been FSUK runners-up seven times and put on a strong show again this year with a car around a carbon monocoque, featuring four in-hub AMK electric motors.

'We have reduced mass in the vehicle by over 10 per cent,' says its team leader, Prescott Campbell. 'Mass was the most valuable parameter for us when we were doing lap time simulation and statistical analysis to predict performance. Every department has played a crucial role.'

Much of the weight reduction came from changing the construction of the bodywork and implementing new laminates. This took approximately 9kg out of the car. The team also reduced the carbon monocoque's weight by 8kg by using more uni-directional fibres.

'Other than that, we have changed our corner assembly, combining the disc bell with the hub and wheel centre into one component,' adds Campbell. 'We also reduced the size of our water-cooling system. The rear motors are still water cooled, but the front motors are now air cooled, and we have 3D-printed aluminium heat sinks on the front motors, with 3D-printed polycarbonate ducts to cool them.'

Steve Miles / IMechE

The winning team posted only the fifth 900+ total point score since FSUK moved to Silverstone in 2007

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After scoring the most points in the static side of the competition, the Technical University of Denmark took to the track in impressive style, claiming top five finishes in the Sprint and Endurance events and second place overall

Primary goal

The team from DTU in Denmark had a single, rear-driven motor, an Emrax 228 axial flux MGU, which was originally designed for aircraft use. This architecture was the more conventional choice among the EV contingent, but DTU managed to combine it well with a compliant, reliable car. That was the team's primary goal, having failed scrutineering each year since its FSUK return in 2022.

'The modules are made so you only have two connections,' explains DTU fourth-year student, Alexander Ewertsen. 'It's just easier to take apart. It's been very good for us in scrutineering because we go through really quickly. The [600V] battery is roughly 8.3kWh, but is probably a little over-dimensioned. The only issue is temperature management, but I think we've got it covered with our settings.'

Wet weather further eased the cooling concerns of DTU and the Basque Country, although attention shifted to making sure no leaks found their way into sensitive areas. DTU's pre-event testing was undertaken on a rainy day, so it knew what to expect. Its car's motor was running at about half the permitted 80kW output as the team didn't want to push it too far in the dynamic events.

'From my experience in the last three competitions, we've seen that the teams that do all events are the ones that do well,' adds Ewertsen. That proved to be the case this year.

The main visual change to the DTU car from last year was the addition of front and rear wings. Many front-running FSUK teams use wings, although there is contention about how much performance they add considering the low top speeds reached. DTU estimated its carbon fibre wings shaved two to three seconds per lap, but it also made them to be easily unclipped if they weren't performant.

The Danish squad was delighted with its overall podium and static victory, considering its current Vermillion Racing team was only set up after the Covid pandemic, when Ewertsen and his course mates discovered the old DTU Formula Student website and started making enquiries around campus.

'After a month or two, we tracked down the people who used to run it, and we just started from there,' he recalls. 'Now, we are about 45 or 50 people. We each work on it roughly 10 hours per week. The university's support has been amazing since the start. They have been supporting us all the way through via their BlueDot programme, for projects that go above and beyond.'

DTU had interest in the programme from about 80 people, though that pales in comparison to Oxford Brookes, which had

Daniel Lloyd

The Oxford Brookes entry featured a 6.5kWh battery with four in-hub motors. The team is set to contest Formula Student Czech Republic in August, where it hopes to use carbon fibre wishbones that didn't make it onto the FSUK car

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University of Birmingham won the Sprint event, despite having to make its run early when the track was still damp

more than 500 students register interest. That number was whittled down to a final squad of around 70 members, 55 of which travelled to Silverstone for the event.

Not only does that make Oxford Brookes one of the largest teams in the competition, it also has some of the best facilities for an FSUK outfit, including its own four-post rig. Its practice for the static events included bringing in external engineers to hold mock scrutineering and judging sessions. That level of preparation made the performance of the relatively inexperienced Danish squad even more impressive.

One fly in the ointment for Brookes was that the team only completed around 50km in testing prior to the event, far short of its 200km aim. This, we were told, was due to additional time spent troubleshooting the car's complex electrical system.

The static events comprised the first phase of the competition and were worth 400 out of a possible 1000 points. As usual, teams had to pitch their car designs to a hypothetical manufacturing firm. Judges then graded the pitches in categories of Cost, Design and Business Plan Presentation. A Laptime Simulation event was also held to gauge the track worthiness of each design.

At the conclusion of the static events, DTU led the Basque Country by seven points, with the University of Glasgow in third place and Oxford Brookes fourth.

Dynamic duel

The all-wheel-drive EVs started the two-day dynamic aspect of the competition strongly. Oxford Brookes won Acceleration, overcoming the wet track surface and completing the 75m blast along Silverstone's

At the conclusion of the static events, DTU led the Basque Country by seven points, with the University of Glasgow in third place and Oxford Brookes fourth

National Pit Straight in 4.284s. The Basque Country finished second, 0.191s behind, setting the stage for an exciting Saturday duel between the two teams. In Skid Pad, the order was flipped around, as the Basque Country won with a time of 5.826s against the 5.959s effort of Brookes.

Day one ended with the Sprint, a one-lap time trial round a cone-laid course on part of the Silverstone track. For the first time, teams could make unlimited runs on the Saturday, ensuring more opportunities to improve, and no shortage of track action. At the end of the day, Brookes emerged with the upper hand against the Basque team, finishing fifth with a time of 58.190s, one place ahead of its rival, which posted a 59.409s. Coventry University, meanwhile, took the Sprint spoils, registering the fastest lap of 55.423s with its ICE-powered car.

In 2024, Coventry installed a new Kawasaki Ninja engine in its car but was underpowered because its planned turbocharger wasn't ready in time. This time around, the turbo system was up and running, delivering more than 90bhp on the dyno. The team sought to maintain a sub-200kg overall car weight by lightweighting other components, such as the uprights, to counteract the additional weight of the turbo and its cooling system. At the weigh-in, it tipped the scales at 195.5kg, around 20kg heavier than it was in 2024, but still light enough to have a decent power-to-weight ratio that helped it around the twisty course.

Other strong performers in Sprint were the University of Bath, which finished second with its EV, and ICE competitor, Cardiff University, which took third, despite having only two out of its three cylinders functioning.

Sunday showdown

At the conclusion of the Sprint event on Saturday afternoon, the Basque Country led Oxford Brookes by 23.1 points. Next in the order was DTU, a further 43.8 points behind. This ensured overall victory would be decided on Sunday, when each team could amass up to 350 points in the Endurance event, which included a fuel (or battery) efficiency score.

Those who did well in Sprint were well placed to succeed in Endurance, due to the weather pattern and the running order.

Historically, EV cars haven't performed as well as their ICE counterparts in Endurance, but the Birmingham car looked extremely stable, and none of the subsequent runners managed to eclipse it

Imperial College London caused a stir when it whizzed through scrutineering on the opening day. The team's car is powered by a Kawasaki Ninja 400 motorcycle engine

Steve Miles / IMechE

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The glorious British summer made for some difficult track conditions, but teams with cooling concerns were happy

The lowest-placed cars in Sprint attempted Endurance first, at which point rain was falling. Then, as the rain stopped and the track started to dry, the leading Sprint contenders entered the fray.

However, to great surprise, it was the University of Birmingham which prevailed, completing 27 laps in 32m 12.4s (with two seconds added for hitting a cone). Its battery-powered car was 10th to run, when the track was drying but still slippery in places. Historically, EV cars haven't performed as well as their ICE counterparts in Endurance, but the Birmingham car looked extremely stable, and none of the subsequent runners managed to eclipse it.

Following this pattern, ICE entrant, Staffordshire University, actually posted the fastest time, but 20 seconds' worth of cone penalties bumped it to second place by less than half a second. Notably, the team had switched from a steel tube frame chassis to an aluminium monocoque for 2025, and had further developed the aero package it debuted last year.

Basque Country finished third in Endurance with a time of 32m 24.75s that earned it 246.1 out of a possible 250 points, plus a 98.8 / 100 efficiency score. This ensured its overall victory, setting a score its closest rivals could not beat. DTU completed the 27-lap course in 33m 5.26s to place fifth, while Oxford Brookes placed seventh.

Some cars that performed well in Sprint lost ground in Endurance, such as Cardiff, whose car stopped on track with electrical issues, and Coventry, whose exhaust system detached mid-run. Bath also had trouble restarting its car during the mid-Endurance driver swap, which it was unable to complete within the maximum three-minute window.

Overseas interest

The 2025 edition of FSUK demonstrated further tentative recovery from the Covid pandemic, in terms of overseas interest. This year saw the arrival of Wuhan University of Technology, the most recent Formula Student China runner-up. Its ICE car produced around 60bhp and contained lots of 3D-printed parts, including PPA-CF filament on the rear wing, to keep overall weight under 200kg. Wuhan flew its car to the UK, allowing a month to pass through customs. It didn't complete any dynamic events, but passed scrutineering, which is often the toughest task at FSUK.

Other well-travelled teams included Nanyang Technological University from Singapore, University of Balamand from Lebanon and ITESM from Mexico, which won the Concept Class, for teams lacking a physical car but taking part in the static events.

The big surprise before the dynamic events kicked off was the early completion of scrutineering by Imperial College London. This was the only team to get all its stickers on Thursday, the rest choosing to wait until Friday, once they had done some of their static events. It was the first time that Imperial, which previously ran in the EV category, had taken part in Endurance since 2013. Unlike the campus universities, which often have kart tracks or disused airfields nearby, city-based Imperial doesn't have any such location nearby to track test its car. Undaunted, the team conducted straight-line runs in an alleyway at the back of the university's chemistry building.

Imperial's ICE design kept things simple, forgoing big wings and focusing on reliability and a stable mechanical set-up. That was a trend among the ICE competitors, whose powertrain choices were usually made for reasons of cost and simplicity.

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In a student competition such as FSUK, there is something to be said for keeping it simple… [but] the teams that managed the complexity of their electric propulsion systems fared best

The new requirement for ICE cars to use sustainable fuels could help students persuade their universities to keep supporting an FSUK programme using such technology. As one student from an ICE team notes: 'There's a lot of pushing from unis wanting to go EV but, if you want a car, we're not going to be able to do an EV.'

EVs are also harder to get through scrutineering successfully, because they require an additional battery inspection.

In a student competition such as FSUK, there is something to be said for keeping it simple. Of the 14 cars that completed the Endurance course, half were ICE-powered and half electric, proving there is no dominant powertrain type yet. However, at the sharp end, the teams that managed the complexity of their electric propulsion systems fared best.

For the University of the Basque country, it was a high point in a 13-year journey with EV cars that included switching to all-wheel drive in 2021. The question now is whether an ICE car will prevail at FSUK again, or if this marks the beginning of an EV-dominant era.

Learning environment

The 2025 edition of Formula Student UK saw further progress for the driverless car competition. While the main FSUK contest is for young mechanical engineers, the FS-AI side of the event encourages computing students to become involved. This year, 25 teams took part, an increase of five since 2024. Of those, six managed to complete the full track drive.

Again, all but one used the stock cars provided by the Institute of Mechanical Engineers, the exception being a plucky bunch from the University of Edinburgh who built their own EV. The majority brought their own algorithms on a disk that slotted into the FS-AI car's onboard computer, saving the cost of developing a mechanical car themselves. For the first time, teams could also bring their own computers to install in the spec vehicle, though fewer than a dozen of them took this opportunity. That number is expected to rise as teams get more used to running the driverless control algorithms.

'Previously, there were IT integration challenges rather than autonomous driving challenges, because they had to get a PC up and running that they had little access to for the rest of the year,' explains Adam Heenan, technical advisor to FS-AI. 'We've made a standard connector on the vehicle that provides power and receives the commands of the CAN network. As long as they have the same connector and CAN interface, they can control the car with their own hardware.'

Another new feature for this year was the option for teams to test their algorithms in an on-site simulator. This enabled them to have a better understanding of whether their controls worked or not before stepping up to a real car. It essentially enabled the FS-AI cars to do more meaningful running, rather than spending most of their time in troubleshooting mode. Teams may also use the simulator software at their own universities to practice away from the track.

IMechE

The number of FS-AI cars doubled to four this year, while the 25 competing teams were able to use simulators to test their driverless controls beforehand

'It seems like more teams are becoming competitive,' notes Heenan. 'Previously, teams were being celebrated when they got the wheels moving. Those teams are now passing inspection on Thursday or Friday, where they prove they can control the vehicle. The level is improving each year.'

Edinburgh won the 2025 competition with a separate team that used the stock FS-AI car, beating Oxford Brookes by 64.2 points.

IMechE

FSUK had more EVs than ICE cars on the grid for the third year in a row, marking the continuation of a worldwide trend. However, internal combustion engines remain a popular design choice due to their simplicity and reduced cost. Only one car with a hybrid powertrain was entered this year, by the University of the West of England, although it ran in ICE spec in the competition

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Development tool

How Jenvey Dynamics has developed a regular racecar into one of the fastest sports prototypes currently competing in the UK

By MIKE BRESLIN

In the hands of Mike Jenvey, the Jenvey Gunn is an extremely rapid machine, posting overall fastest lap times on the Silverstone International layout and at Brands Hatch Indy in 2024

Motor racing is supposed to be about making a car faster, and yet these days technical development is tightly restricted in most categories, and performance balancing is rife. Thankfully, there are still people involved in the sport who enjoy the challenge of relentlessly honing their machines, and there are still series where this sort of development is allowed. One such person is Mike Jenvey, and one such series is Equipe Sports Prototypes.

Jenvey's introduction to racing was through his father, Richard, a well-known sportscar driver in his day who raced at the 24 Hours of Le Mans in 1979. Jenvey junior followed in his footsteps and has now competed for 25 years, initially in Formula Vee, and then in Sports 2000 with the Gunn he now campaigns in much-modified Jenvey Gunn form in Equipe Sports Prototypes – a sort of closed-wheel Formula Libre that is home to LMP3s, Radicals and an assortment of sports racers.

There's no doubt Jenvey has had a very successful career as a driver – he's won 84 races and six national championships – but the name is better known to most for the throttle bodies the family firm, Jenvey Dynamics, is famous for (see box out on p58). Indeed, part of the reason for the constant development of the Jenvey Gunn is to help improve the company's products.

That said, the main reason remains outright performance, and on that score this car certainly does not disappoint, being one of the fastest sports prototypes currently racing in the UK. In 2024, it took the outright lap record for the Silverstone International layout and the fastest race lap of the year at Brands Hatch Indy, while it regularly posts times close to the very quickest LMP3 and GT3 cars, where comparisons can be made.

Son of a Gunn

The Gunn TS6 was originally designed and built as a Supersports car by Gary Gunn, and Jenvey bought it at the end of 2006 to compete in the Sports 2000 championship, which he went on to win twice. He remained in Sports 2000 until the end of 2012, then switched to the Open Sportscar Series (OSS), a forerunner of Equipe Sports Prototypes, but the development of the car, which for many years was a team effort between Mike and his father, started long before that.

'We bought the car because it looked like it had a low centre of gravity, it was wide and low for creating downforce, and we were impressed with the innovative pullrod suspension,' says Jenvey.

The first job was to redesign the pedal box – a comfortable car has always been important to Jenvey – and a little later the water radiators were relocated from the front to the rear to help reduce high-speed understeer. Then, after the first season, the spaceframe came in for attention: 'We extensively modified the chassis, measuring stiffness, then cutting out chassis tubes and temporarily welding in new tubes, and measuring again until we were happy with stiffness and weight,' Jenvey continues. 'At the same time, we redesigned the front suspension, manufacturing our own wishbones and billet aluminium uprights.'

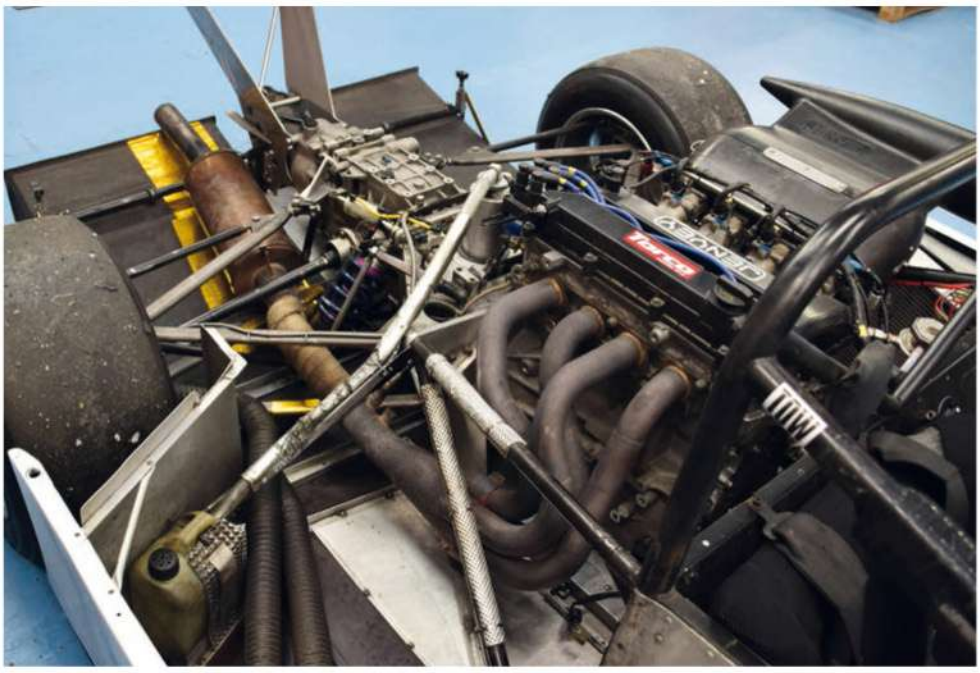
This, and subsequent work, made the car significantly lighter, so when it was in Sports 2000 guise it ran with 20kg of ballast. These days, the car tips the scales at 525kg, pretty light for a racecar of this size, though that has taken some extreme weight loss measures to achieve. Drilling lengthways through the M10 bolt that holds the alternator cover onto the block is just one example.

'We bought the car because it looked like it had a low centre of gravity, it was wide and low for creating downforce, and we were impressed with the innovative pullrod suspension'

Mike Jenvey, managing director at Jenvey Dynamics

The original Gunn spaceframe has been steadily modified over the years to increase stiffness and reduce weight– note the stressed aluminium panelling around the cockpit – always with an eye on making the car's c of g as low as possible. The car now weighs 525kg

While the car was bought by Jenvey as a Sports 2000 racer, it was originally designed and built in the 1990s as a Supersports racer. The GRP bodywork has been extensively re-modelled since, but remains in the Gunn format of lift-off front and rear sections



Power comes from a heavily modified 2.0-litre Ford Duratec that's been tuned to produce over 300bhp and currently uses a prototype Jenvey profile throttle body inlet. Note the tortuous routing of the unusual four-into-one exhaust through the suspension

Pullrods front and back work two-way adjustable Quantum dampers that Jenvey says are almost never adjusted as he's happy the car is operating in its sweet spot. The rear suspension was rearranged when the Hewland JFR six-speed gearbox was fitted

What the Jenveys really focused on, though, was having the weight low in the car, so another early modification was to lower the Gunn by 6mm by repositioning the floor. Since then, the spaceframe has been bolstered with double skinned aluminium panelling around the cockpit, which has further improved its rigidity.

The transformation of the car to Jenvey Gunn-spec has also included remodelling the GRP bodywork to increase downforce and reduce drag, although it remains Gunn in concept, being a two-piece arrangement with separate front and back sections.

'A beautiful thing with Gary's design is that you can take the two bits of bodywork off in a minute, and the whole car is accessible,' notes Jenvey. 'With other cars, you remove a panel, and you can just about get to the engine.'

Highly strung

It's useful that it is easy to access the engine, as the 2.0-litre, four-cylinder Ford Duratec that powers the car has received a great deal of attention over the years. In standard form, the Duratec produces around 145bhp, but about 200bhp in Sports 2000 spec. The example in the Jenvey Gunn now puts out 313bhp, which

In standard form, the Duratec produces around 145bhp, but… the example in the Jenvey Gunn now puts out 313bhp

gives the car a power-to-weight ratio of close to 600bhp per tonne, while it's revved to between 9100 and 9300rpm, depending on the circuit it is competing on.

For a power unit originally designed as a roadgoing engine, that is a lot of revs, and Jenvey admits that competing with this sort of power unit can be a challenge: 'These 2.0-litre sportscars are hard to manage because, if it's going to be competitive, the engine is on the limit. They are light, because they are so simple – there are no turbos, no superchargers – but also highly strung.'

Early developments saw the engine upgraded with cams and pistons, but still with the standard crank. As successively more aggressive cams were tried, these created their own issues. 'When we first made that jump, we had a lot of problems wearing cam followers out,' admits Jenvey. 'So we now do our own mods to the cams when they come in. We also went to a steel crank. We think something wasn't right with the standard crank's harmonics at high revs. Going to a steel crank and, at the same time, going to a traditional single roller cam chain, solved many of our problems in one go.

'The biggest single improvement, though, was grooving both halves of the main bearings, which cured the engine's desire to seize big ends.'

Butterfly catcher

Unsurprisingly, the inlet system is by Jenvey Dynamics. This comprises prototype Jenvey profile throttle bodies, eight injectors, Jenvey ETA2 electronic actuation, a Jenvey fuel swirl pot and prototype micro fuel filter.

'We've been running a profile butterfly system on there for a few years, which is going into production at the end of this year,' says Jenvey. 'It also runs our electronic throttle actuator and our fuel swirl pot for classic and racecars. So the car is kind of a development tool for Jenvey Dynamics.'

To make sure the Jenvey intake system gets as much positive pressure as possible, the car sports a snorkel-style airbox that resembles those used in traditional Formula 3, though unrestricted in this case. It sits right in the airflow and, says Jenvey, makes a huge difference to the performance of the engine.

Other key components include a CNC-ported cylinder head and Jenvey-developed valve springs. The latter came

'The [bespoke] valve springs have probably knocked 10 degrees off the oil temperature, and everything's in control now, rather than right on the limit'

Mike Jenvey

about because the originals had very high seat pressures, which caused some issues at increased power levels. The bespoke items had a happy knock-on effect in helping solve what had been the most frustrating problem with the engine: overheating.

'With sports prototypes, cooling is often the biggest challenge,' Jenvey says. 'We were seeing a lot of very high oil temperatures. People would look at the car and say, "just put a radiator in the other side" [there is currently just a single unit on the left side], but I like to have a lot of air going through the exhaust side to get rid of the exhaust heat, cool the gearbox and energise the diffusers. In 2021 / '22, we probably went through 15 different cooling configurations with water and oil. Every race we went to we'd turn up with a different set-up to test in qualifying, but we were always running on the limit with the temperatures.'

It's working now though and, surprisingly, it was those bespoke valve springs that made the difference. 'The valve springs have probably knocked 10 degrees off the oil temperature,' says Jenvey, 'and everything's in control now, rather than right on the limit.'

Peak power

The team has also taken an interesting approach with the exhaust. Rather than the four-into-two-into-one configuration common with this type of power unit, this is a four-into-one, which Jenvey says improves peak power, as opposed to giving a better torque spread. That said, the torque curve is still surprisingly flat and strong, proven by the fact Jenvey took the overall fastest race lap at Brands Hatch Indy last year while stuck in fifth gear!

Jenvey's current aim is to boost power output to 320bhp, and bigger production throttle bodies will be fitted soon, while some higher spec slipper pistons, longer connecting rods and titanium valve spring retainers are being experimented with.

Meanwhile, Jenvey Dynamics has a long and fruitful history of taking in 'sandwich' students, those doing degrees that include a placement year in industry, and the most recent of these, Owen Stokes, has been working alongside lead race engineer, Michael Hunkin, at the races. He has also been modelling this engine for his engineering masters' dissertation, which will mean a further examination of the exhaust and the intake system.

Flat floor feeds into the aggressive twin-tunnel diffuser, but the real aero hero at the rear is the dual-element wing, which, when fitted, was responsible for a 25 per cent hike in downforce and 20 per cent reduction in drag

Rear wheel covers are due to be opened up shortly to prevent airflow sticking beneath the bodywork at the rear. F3-style airbox sited in clean air on the left-hand side of the car is said to have improved engine performance enormously

Further down the line, if the Duratec becomes uncompetitive, Jenvey would love to fit a Powertec (Radical) 2.7-litre V8, but says he would not consider turbocharging or supercharging the current power unit, largely due to the cooling issues he has experienced with it in the past.

The engine is controlled by an MBE 9A9 ECU, which also looks after the paddle shift, and is a hybrid Radical / SBD Motorsport unit. This actuates a six-speed, close-ratio Hewland JFR gearbox, while the car also has a limited slip differential. 'We'd heard that [traditional] F3 was running quite open diffs, with very little preload,' says Jenvey, 'so that's how we've set this up, because it's on the same [Pirelli] tyres as F3. It is a bit heavier than F3, but it's also more powerful. We've never really played around with differentials, but for quite a while it used to lose its preload, so we'd be re-shimming the differential probably every four races. Now it's stable, I've not touched it for two years, other than to go in and check all the teeth are okay.'

Springs and dampers

The Gunn came to Jenvey with pullrod suspension front and back, and this meant the shocks and springs were sited low and flat in the car, a big plus for Jenvey in the eternal quest for a low c of g. Since buying the car, though, the suspension at the rear has also been modified.

The neat little turning teeth along the outer edge of the base of the sidepod inlets help with engine cooling – something that has been a big issue in the past. Only one radiator is used as Jenvey prefers to keep the other side tunnel clear to help exhaust cooling

The phenolic-coated plywood front splitter has grown in size over the years and is angled upwards slightly to draw more air under the car. A new version is currently under development

TECH SPEC: Jenvey Gunn TS6

Chassis
Gunn TS6 Supersports / Sports 2000 modified by Mike and Richard Jenvey; spaceframe with aluminium stressed panelling; GRP two-piece bodywork

Engine
2.0-litre, four-cylinder Ford Duratec; steel crank; uprated pistons; CNC-ported head; Jenvey valve springs; single roller cam chain; modified cams; F3-style ram airbox; four-into-one exhaust system; Torco oil supplied by Nimbus Motorsports

Induction: Jenvey prototype profile throttle bodies; Jenvey ETA2 electronic actuation; eight Siemens injectors; Jenvey fuel swirl pot (FS2-FP20); Jenvey prototype micro fuel filter.

Power: 313bhp

Transmission
Hewland JFR six-speed, close-ratio gearbox; Radical / SBD Motorsport hybrid paddle shift controlled by ECU; limited slip differential

Suspension
Pullrod-actuated Quantum two-way adjustable dampers; unequal length wishbones top and bottom; front and rear anti-roll bars (rear adjustable from cockpit); heave spring in development

Aerodynamics
Flat floor to bulkhead; twin-tunnel rear diffuser; front splitter; Reverie double-element carbon rear wing

Cooling
Single radiator; AHS Fabrications oil and water heat exchanger; heat protection supplied by Nimbus Motorsports

Electronics
MBE 9A9 ECU; VBOX HD2 video and datalogger supplier by Goldstar Onboard

Brakes
AP Racing 267mm discs; AP Racing calipers; Mintex F2R pads

Wheels and tyres
Rays Macau-spec F3 wheels; front tyres: Pirelli 200/540-13 slick DMA; rears: Pirelli 250/575-13 slick DMA

Weight
525kg (approx. 42 per cent front / 58 per cent rear)

'It's still pullrods front and rear,' confirms Jenvey. 'You can get quite high loads with pullrods, so we've kept that, but we redesigned the rear suspension. It was really good, but at Mansfield, at the bottom of the hill at Cadwell Park – we don't know why it was that corner specifically – it used to bend things. So, we ended up redesigning and manufacturing a new bellhousing and rear suspension when we put the new gearbox on, and that's been reliable ever since.'

The main change was lifting the bottom rear wishbone, which also opened room for a bigger diffuser. 'The suspension is interesting because it's very traditional, with a short top wishbone and a long bottom wishbone [front and rear],' explains Jenvey. 'This helps grip by minimising track change at the contact patch, while at the same time increasing camber in roll. A lot of modern cars don't do this, they just have equal length wishbones that they bolt on wherever they can, but I think this makes a big difference.'

Sweet spot

Dampers are Quantum, two-way adjustable, and the ones that came with the car. 'We're probably a bit heavy for the dampers,' admits Jenvey. 'They're F3 dampers, essentially. The last time I adjusted them was probably two years ago. In Sports 2000, we used to adjust them a lot, but we find with this we've got bigger stuff to do, so we might change a spring rate, but we won't change the damper to match. I guess this is because the car is now in a sweet spot. We'd often use dampers to help with initial turn-in and balance, but it's so balanced now we don't need to do this.'

There are anti-roll bars front and rear, too, the latter adjustable from the driver's seat by one of the few controls, switches and readouts in an intentionally spartan cockpit. When it comes to the spring rates, these are largely dictated by the aero.

'Spring rates have just gone up and up as the aero has increased,' says Jenvey. 'The front's now really hard, and we actually run the front slightly higher than we'd like to, which means it has something like 15mm movement before it hits the bump rubbers and goes solid.'

There's an extra spring / damper arrangement to come, again to do with the aerodynamics: 'We have a third element in design at the moment. I'm lucky that I've had students who had placements here who have helped. Last year's student, Harry Needle, his

final year project was heave suspension, and we are going to fit this to the front of the car.'

A third element is all about holding the chassis up when it's under aero load, and this machine certainly produces plenty of that, with an estimated 300kg of downforce at the front and a little more at the rear.

Polished floor

As is the case with many sports prototypes, the floor contributes greatly to this. 'It is very flat, it's polished, and we put a lot of effort into that,' says Jenvey. 'Every year we have the car apart, we'll turn it upside down and repair all the floor.'

The flat floor extends back to the bulkhead, just behind the roll hoop, where there's then an incline of about an inch, a sort of gradual diffuser. The actual diffuser starts just in front of the rear wheels and is a twin tunnel-type arrangement, with the exhaust exiting on top of and between the two channels.

'We run the exhaust out the rear because we figure it must give us some forward motion and also help the diffuser,' Jenvey continues. 'It's really hard to get it through the suspension, but we've managed to do it.'

This means there is also some extra high energy air going under the carbon fibre, dual-element rear wing, made by Reverie, which has been on the car for two years now, having replaced a previous single-plane wing. 'Going from a single to dual-plane wing added 25 per cent downforce,' notes Jenvey, referring to aero analysis done on the wing, 'and there was also a 20 per cent drag reduction. The actual main plane looks flat now, but it works, so I'm not going to argue. We get a huge amount of downforce from this.'

Meanwhile, at the front there's a substantial, phenolic-coated plywood splitter. 'That's grown and grown and now it's probably as big as it can practically be in the material it is,' says Jenvey. 'It is also now angled slightly up, just to draw more air into it.'

The front splitter and diffuser arrangement is the area earmarked for the next stage of the car's development, while adding vents in the bodywork over the rear wheels, and bigger diffusers at the rear, are also on the to-do-list. Interestingly, though, there are no thoughts of moving to a high nose, as that would require major alterations to the chassis.

Incidentally, the nostrils, slightly reminiscent of the 1999 Le Mans-winning BMW V12 LMR, are for brake cooling.

Flow motion

As highlighted earlier, cooling is a major consideration on the car, and there's a big radiator and a very large oil-to-water heat exchanger, made by AH Fabrications, in the left side of the spaceframe. The weight imbalance is offset by the position of the driver in the right-hand-drive cockpit.

Heavenly bodies

Both pretty and effective: Jenvey Dynamics products can be found on a wide range of race and road engines across the globe

Jenvey Dynamics, which is based near Bridgnorth in Shropshire, UK, is best known for its throttle bodies, but actually produces entire induction systems, including manifolds, fuel rails, linkages and fittings, which it supplies to a host of well-known British companies, including Radical, Caterham and Norton Motorcycles.

The USP of the company, which was founded by Richard Jenvey in 1987, is that it does everything in-house. And we do mean *everything*. It has its own foundry, where very thin wall aluminium castings are produced, four seats of SolidWorks for design, eight CNC machines (with one more on the way in the machine shop), and another that carves patterns 24/7.

Quality control is 100 per cent inspection, with a QC bench in each section, and the finished parts exude quality – something that's important for the classic road car market Jenvey also sells into. 'We're always driven primarily by function, and weight probably sits just behind that,' says managing director Mike Jenvey, 'but we always try and make our products look great, too.'

The firm's business is split between motorsport, classic and niche OEMs, with significant exports to Europe, the United States and the rest of the world.

Jenvey very rarely goes testing, due to time constraints as much as the cost, so most of the big changes that have been made over the years are 'tested' during qualifying at an event

There are also neat little turning teeth situated along the bottom of the sidepod air inlets, which, Jenvey says, have made a noticeable difference: 'When it rains, you can actually see the lines off them, and they are ridiculously effective.'

In fact, this is a method the team often uses for aero development: 'We use rain a lot, and oil. Last year someone had an oil leak, and I followed them, then came into the pits, and we took something like 30 photos of the car before wiping the oil off,' says Jenvey with a smile. 'Also, when it rains, you can see a lot. We knew, for example, that the air was detaching from the bottom of the single-plane rear wing. That made the final decision to go to a dual-plane wing easy for us.'

The aero package on the car is now very effective, and the car is well balanced, with a slight trait to understeer, according to Jenvey. It certainly works, for as well as the overall fastest laps mentioned earlier, the Jenvey Gunn also won both races at the first 2025 Equipe event at Brands Hatch quite comfortably. What makes this success all the more remarkable is that Jenvey very rarely goes testing, due to time constraints as much as the cost, so most of the big changes that have been made over the years are 'tested' during qualifying at an event.

That doesn't stop progress, it just makes it more of a challenge, but it's difficult to envisage a time when the development of this car will ever stop. But then, isn't that how motor racing is supposed to be?

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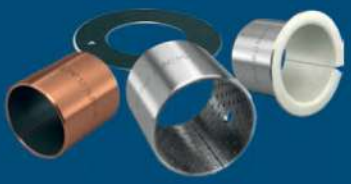

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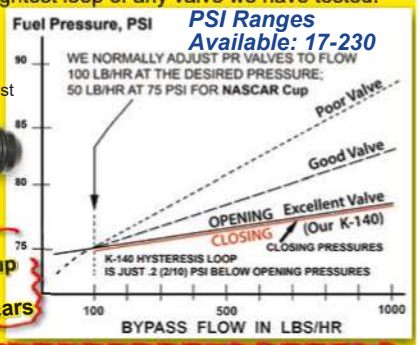

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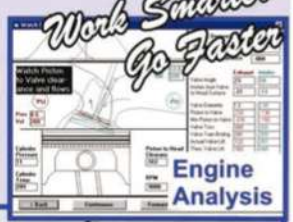

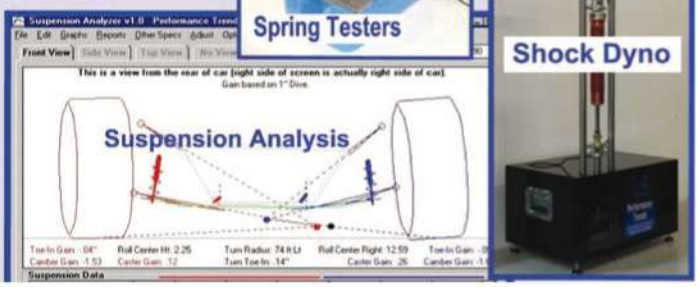

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Prescription power

With control strategies fast becoming the critical performance differentiator,* Racecar *looks at their methods of implementation

By LAWRENCE BUTCHER

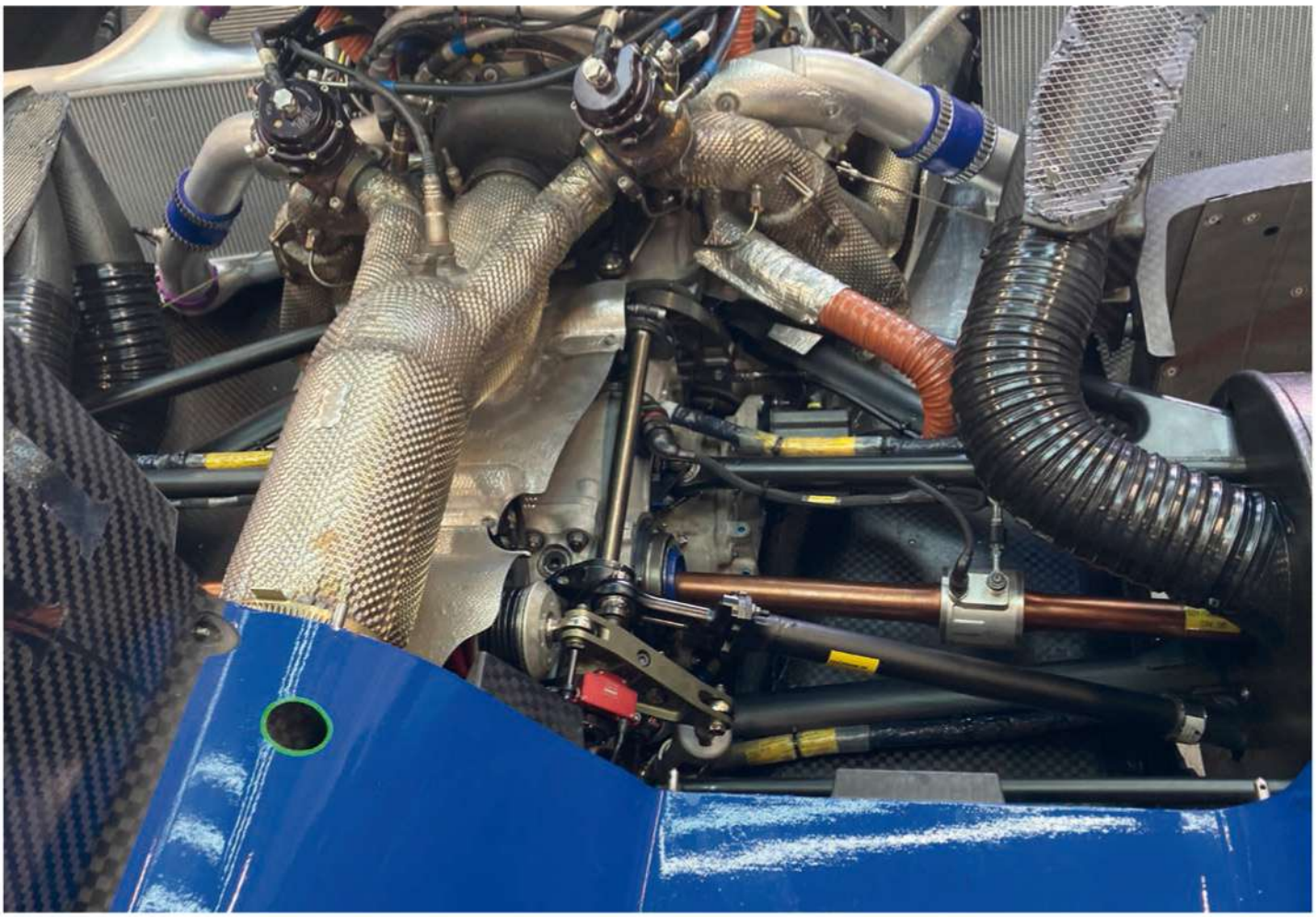
The arrival of torque sensors as a tool for Balance of Performance (BoP) seems like a straightforward solution to curbing the escalation of engine development. At first glance, having a prescribed power curve and a maximum power limit, both precisely monitored by an accurate sensor, should do just that. After all, it is all well and good dynoing engines prior to a season and producing a graph saying they are within the rules, but the smallest changes in real-world conditions can quickly render any such standards null and void.

This, however, is motorsport and, if there is a line to be pushed, you can be sure it will be pushed, from every direction. *Racecar Engineering*'s own Lauren Mills came up with the perfect analogy: working with BoP and torque meters is like the fairground game 'stop the clock'. The winner is the one who stops the clock closest to 100. Instead of a clock, though, the goal is the power limit. Engineers want to stop the power as close to '100' as possible. Under it and you are missing an opportunity, but go over it and you risk a penalty. In a simplistic world, the answer would be to use the output of the torque sensor as part of a closed-loop control system for the powertrain. If the torque limit is hit, the ECU automatically cuts fuelling to the engine, or pulls power from the hybrid. Problem solved.

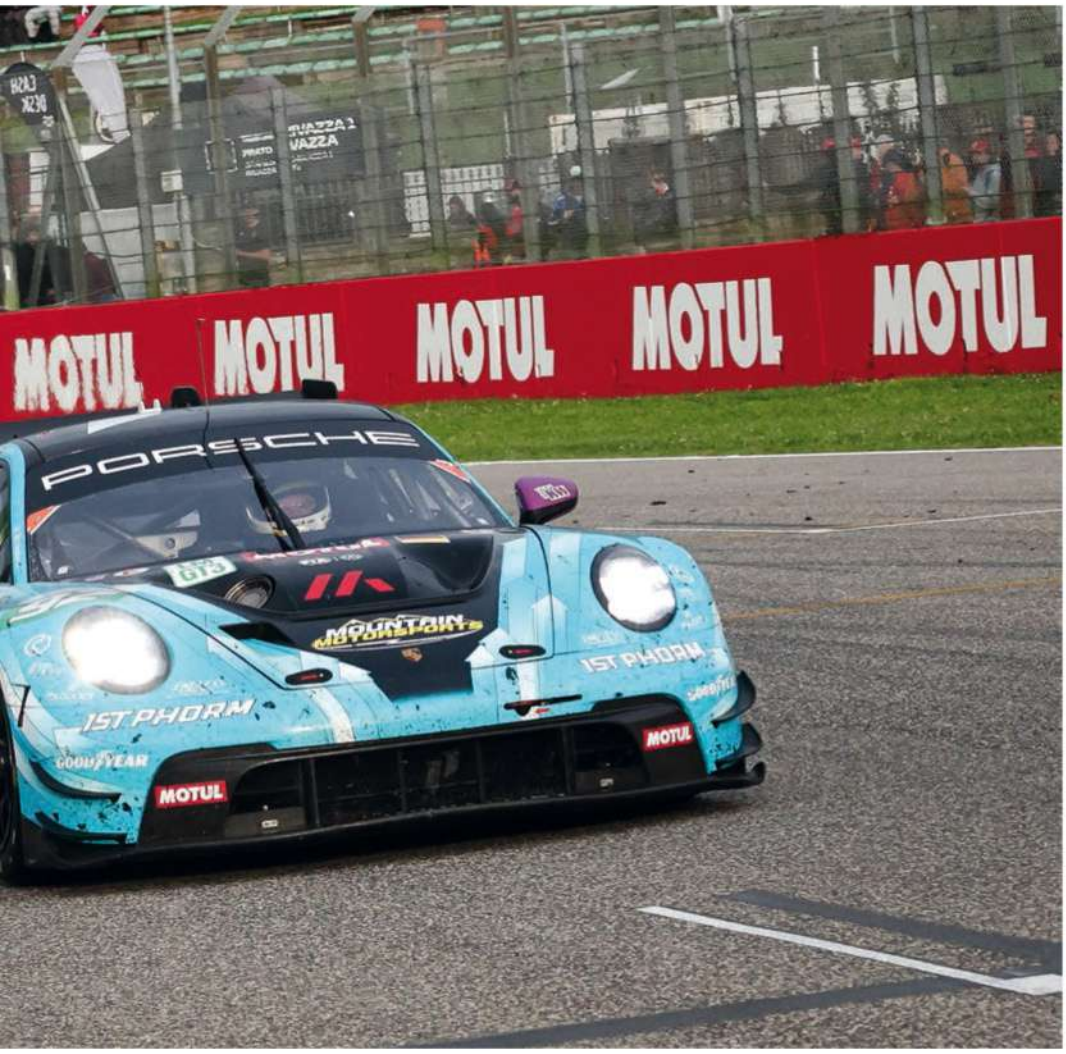
The trouble is, no vehicle drivetrain – whether the hybrid in an LMDh or traditional ICE of a GT3 – is entirely linear, or instantaneous in its response. From variations between each combustion cycle through to the stacking up of compliances in the drivetrain, running right up to, but not beyond, a precisely policed torque limit is far from straightforward. And there is the hidden development war; being able to eke out even a fraction of a per cent more of the power allowance than your competition can make the difference between winning and losing over an endurance race distance.

Physical considerations

In LMDh / LMH and GT3, homologated magnetoelastic torque sensors from supplier MagCanica are fitted to the driveshafts, two in the case of rear-wheel drive only and four where all-wheel drive is employed.



The driveshaft-mounted MagCanica torque sensor is the product of choice in the WEC and IMSA. The ECU controls engine output working on signals received from this sensor in a closed-loop system



Being able to eke out even a fraction of a per cent more of the power allowance than your competition can make the difference between winning and losing over an endurance race distance

Porsche and BMW have very different architectures, each with their own challenges, but both are getting to grips with torque sensor control in the World Endurance Championship

Jake Galstad

Having a long propshaft between a front engine and a rear-wheel drive mechanism leads to oscillation, which has to be controlled, or at least monitored, leading to even more sensors on cars

Looking at even the simplest drivetrain layout, such as a mid or rear-engine GT car, you have a torque transmission system consisting of the ICE, a clutch, transmission, differential, driveshafts and, of course, the tyres.

Calibrating the ICE in isolation to hit a predetermined power output at a steady state on the dyno is relatively simple. Start to throw in other factors, though, and this becomes more challenging. From talking to engineers across both the LMH and GT3 field, it has taken considerable time to understand the influence of each of these, from the aforementioned compliances through to the behaviour of tyres and the influence of kerbs.

Every element of the drivetrain has the potential to act like a spring, each with a varying stiffness, from the tyre to the driveshafts and even the internals of the transmission. As Leonardo Galante, CTO of Tatuus, explained during his previous role at Lamborghini Squadra Corse in 2024, 'It is not too difficult to control in a steady-state phase, like on the straight where everything is good, but when you go out of a corner and the driver is pushing on the gas, you have a lot of [tyre] slip, and this creates oscillations through the driveline. These can be very difficult to control and it is easy to go over the limit. This phase is absolutely critical.'

Every element of the drivetrain has the potential to act like a spring, each with a varying stiffness, from the tyre to the driveshafts and even the internals of the transmission

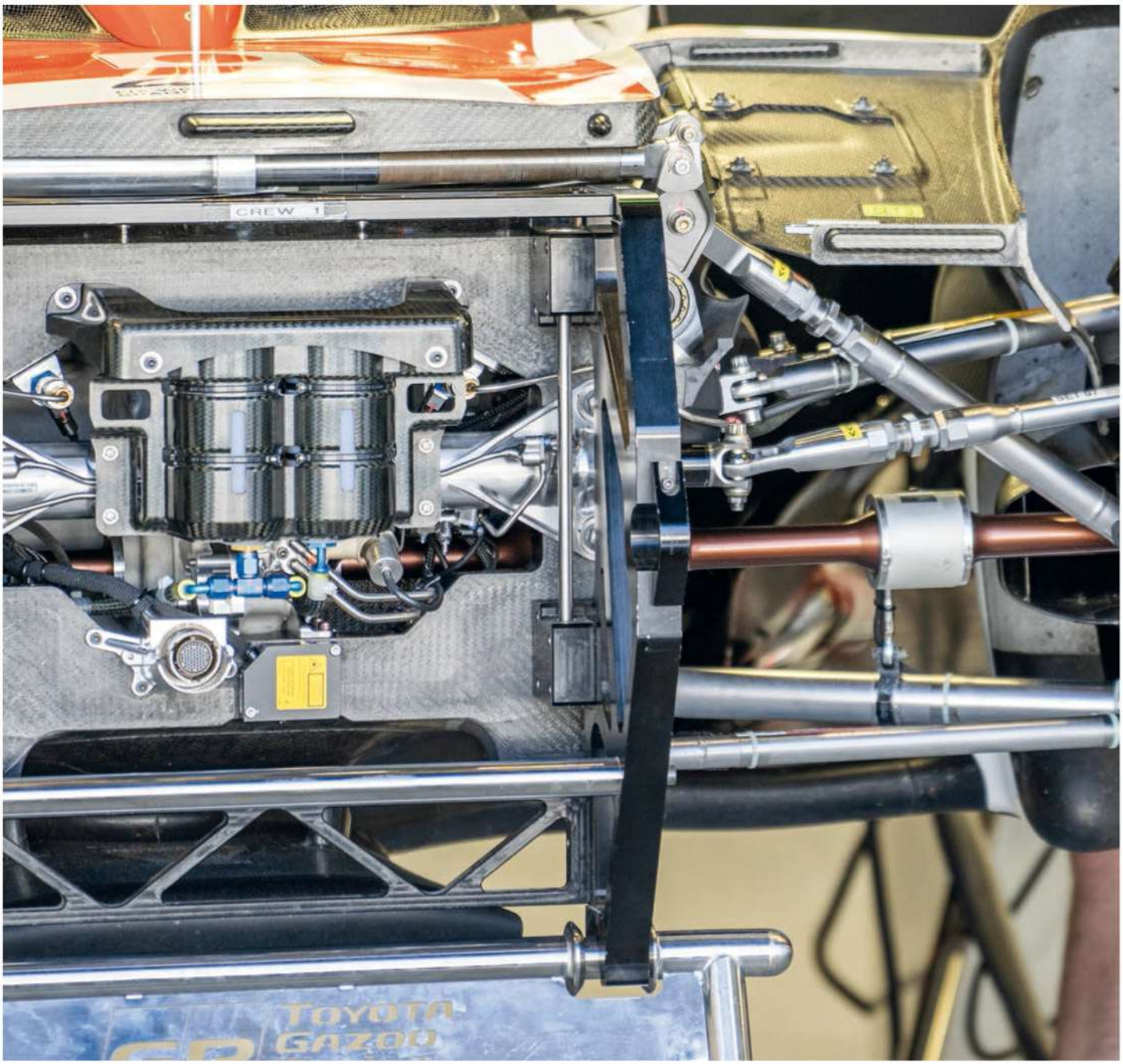
It is here that the varying levels of stiffness through the driveline play a vital role. As the tyre winds up, slips, and then grips and begins to wind up again, the amplitude of the oscillations is dictated to a degree by the stiffness of each component. Therefore, in order to run close to the torque limit, teams must have an intimate understanding of the interactions within the driveline to be able to model them, and then use their modelling to inform the powertrain calibration.

The more complex the drivetrain, the more complicated this balancing act becomes. If you have a front-engine, rear-wheel drive GT car, with a long propshaft, this adds another area of compliance. This is likely one of the reasons why several teams have been running additional torque sensors on their cars, of the Surface Acoustic Wave (SAW) type, to provide real-world data on these oscillations that can potentially be used as inputs for control strategies.

Hybrid complications

Introduce a hybrid system and things become both easier and more complicated at the same time. With an LMH platform, using a front-mounted MGU and a rear-mounted ICE, keeping under the torque limit should, in theory, be easier, provided you are in a section of the track where the MGU can be deployed (LMH has a minimum deployment speed of 190km/h by regulation). If the MGU is in use, then whatever torque limiting strategy you have developed can harness the greater responsiveness of the electrical machine, which, in theory, should allow a more aggressive approach to the maximum.

However, as Stefan Moser, LMDh technical director at Porsche, pointed out when discussing the 963's powertrain development in 2024, the hybrid also brings added complexity. 'It becomes a question of calibrating the entire drivetrain, as it is a combination of the e-motor and combustion engine. That makes it more complicated, with more people involved, more interfaces, and the control for the e-motor is a different ECU to the ICE, so they both need to work together.'



Torque sensors are finding their way into an increasing number of race series these days (WEC car shown). Though the up-front cost can be high, they offer accuracy, reliability and repeatability

'You have a big mass on the gearbox, and you have the engine on the other side. In between, you have a shaft. Those two masses work against each other, and that creates vibrations, which is really a challenge'

Stefan Moser, Porsche LMDh technical director

With the LMDh layout, the arrangement of the hybrid on the rear axle creates more dynamic intrigue. With the MGU mounted on the transmission, the mass of the rotor comes into play. 'You have a big mass on the gearbox, and you have the engine on the other side,' explains Moser. 'In between, you have a shaft. Those two masses work against each other, and that creates vibrations, which is really a challenge.'

Incomplete picture

Even if you create a perfect digital twin of the entire driveline, validate that model and use it for calibration, that is still not the entire answer. Neither the tyres nor the track is a static entity, each evolving through the duration of a race, or with changing weather conditions. This introduces yet another degree of complexity that needs to be modelled and accounted for. So, teams need a variety of options available for drivers to cycle through as a race progresses.

Then there is the matter of individual driving style. No two drivers are the same, and each will attack a corner in a slightly different way. This is particularly relevant in multi-class racing where, due to traffic, unusual lines frequently have to be taken.

Here's where the issue of kerbs comes into play, especially with drivers who take them as a vague suggestion of the track limits. Transmission designers have long been aware of the shock loadings a gearbox takes if a driver shifts while they are on a kerb. Revs jump suddenly when a wheel is off the ground and then, when traction is regained, a further significant torque spike occurs.

With torque sensor BoP in force, any such spikes need to be avoided, or at least compensated for. As the prescribed power limit is an integral of torque, rpm and time, very brief spikes can be mitigated by backing the power off immediately following any spike, but the problem then is you are cutting power where it makes the biggest difference to a driver, which is coming out of a corner onto a straight.

In Lamborghini's case, it relied on drivers to switch manually between compensation strategies from corner to corner. '[We map it] that this corner is very crucial, so you need to have more conservative control there. The curves are flat, so the grip is high, and then you can go a little bit higher with the power control. It is characterised for every single sector, even mini sector, of the racetrack, for every race, and you need to switch the control diagram for every single turn,' explains Galante.

If you think this sounds unfathomably complicated for a driver, it appears – though no one is prepared to go on record to explain it – that most teams have now automated this approach, so are not reliant on their pilots to manually adjust the map on the fly.

Trickle-down tech

Across the FIA World Endurance Championship, teams have got up to speed at varying rates in their understanding of how to handle torque sensors, but it's fair to say huge resource has been expended in the struggle to avoid being left behind.

Larry Holt, executive advisor at Multimatic, concurs. He has said that in the early days of the Multimatic-built Ford Mustang GT3's competition life, mapping the torque control system was subject to massive effort: 'Ford's system is pretty sophisticated. I mean, we

As the prescribed power limit is an integral of torque, rpm and time, very brief spikes can be mitigated by backing the power off immediately following any spike, but the problem then is you are cutting power where it makes the biggest difference to a driver

Having a front-mounted hybrid system means double the number of torque sensors for the LMH cars, but potentially more straightforward control. Ferrari has clearly got its mapping right having won the first four races of 2025 including Le Mans

Jake Galstad

Lamborghini's SC63 prototype ran in the WEC in 2024 and now runs in IMSA. Integrating torque sensors into race strategy and ECU management was one of the major challenges faced by its teams in prototype and GT racing, with the normally aspirated Huracán model. Lamborghini, like others in Hypercar and GT competition, has improved its knowledge of the sensors, and laptime

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The easy answer would be to prevent teams from using the torque sensor signals as a control input and ignoring torque spikes that do not contribute anything to real-world performance

[Multimatic] were involved, but really 100 per cent control of the control is with Ford, and they put an army of very clever people on it. Back at Imola [the second round of the 2024 WEC season] we didn't even really have any kerb compensation. Now we know where we are on the target and know when we are on a kerb [by Le Mans 2024, following further fine tuning of the system at Spa].'

Given the significant effort put into development of these control strategies by works teams, how might the use of torque sensors work in the wider world of GT3, where the capabilities of teams, and manufacturers, vary considerably? It would be very easy to imagine a situation where, despite BoP saying everyone is equal, there would be a situation of haves and have nots.

The easy answer would be to prevent teams from using the torque sensor signals as a control input and ignoring torque spikes that do not contribute anything to real-world performance. Instead, the regulators could develop a monitoring algorithm to smooth out these spikes and correlate them to track position. After all, the kerbs are not a moving target, and the position of every car on track is known precisely in most series. It would then be a case of looking at the power curve under steady-state running and pinging teams if they overstep the limit.

Of course, there is still the significant matter of the up-front cost of torque sensors, and the ongoing maintenance of such a system. Plus the fact that teams will *always* look for ways to game the system. Still, such an approach could negate the worst of the development battles the WEC has seen, leading to a fairer, more affordable and more easily policed Balance of Performance.

Racecar says

Pretty much everyone involved in racing agrees that torque sensors are needed to monitor and equalise very different powertrains, but how to integrate them into the various racing series without drastically adding cost is the key sticking point. Right now, only manufacturer racing, such as the FIA World Endurance Championship, uses the driveshaft torque sensors in a closed-loop system, where torque is controlled by the ECU, which itself is responding to signals received from the sensor. IndyCar is also using the system, but with an input shaft sensor that is said to be cheaper to run.

Even within a closed-loop system, there are multiple strategies that can be used. One is for the ECU programming to predict the layout of the circuit, the conditions, the tyres and account for any potential spikes in torque demand that might arrive. This is by far the most complicated to manage and the most expensive to implement, but leads to a quicker lap time.

A second method of control within a closed-loop system is for the car to automatically react to certain inputs. So, if a car runs a kerb, or hits a bump, it triggers a cut in torque demand. This leads to a slower lap time, and a less comfortable ride, but is a good option if teams cannot afford the predictive method.

For customer GT racing, using an open-loop system might be the best compromise between monitoring power delivery and minimising cost increases, but it comes at the expense of detail. An open-loop system would require no engineering input from the team, and there would be no interference in car management. In fact, that would be discouraged. Teams would be given the BoP parameters as they currently are, and would not have access to the checking system, which would only be used by the sanctioning body. This method is less involved, as well as cheaper and quicker to install. It might not be perfect, but then customer racing should never be about that last tenth of a second.

GT World Challenge is about to start its path to torque sensors, although finding a cost-effective method of doing so is imperative if the series is to retain its full grids in the future

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Plan of attack

Part two of a concept for revitalising open-wheel racing around the world

By DANNY NOWLAN

KSP ADAC

F4 can be a good starting point for learning about data acquisition, with further layers of complexity added as engineers progress up the single-seater ladder towards F1 and IndyCar

You don't have to be a rocket scientist to figure out that the current state of open-wheel racing is a bit unbalanced, to put it politely. I first wrote about this subject last year when I was making observations of the situation that British Formula 1 driver, Oliver Bearman, faced when he subbed for Ferrari's Carlos Sainz at the 2024 Saudi Arabian Grand Prix.

I wrote back then with a great sense of alarm, but now, a year further down the line, seeing what I'm seeing with junior F1 drivers being totally out of their depth, not to mention junior engineers, I'm writing this with a genuine sense of panic.

While I'm about it, I'll make a couple of tweaks to the article I wrote last month about Formula Ford.

To start, let's put this all into perspective by winding the clocks back to the 1970s and '80s. Back then, while hardly a straightforward affair, teams *could* work their way up from Formula Ford through Formula Ford 2000, F3, F2 / F3000 and up to F1 and / or IndyCar. The last most famous example of this is Jordan Racing, which evolved into Jordan Grand Prix and, eventually, into the Aston Martin F1 team.

Also worth noting here is that in the last year of the technical-free era of F3000, when track testing was unlimited, pole times were within spitting distance of their F1 brethren. Little wonder, then, that the likes of Damon Hill and David Coulthard could slot straight into a championship-contending Williams F1 car and give a good account of themselves.

Mind the gap

Fast forward to now, though, and the gaps between cars in different series are far greater. Add to that the fact that F1 is now a closed shop. Not just because the entries are so tightly controlled, but because the junior formulas, in particular FIA F4 to F2, are so restricted that opportunities for these teams to graduate are near impossible.

To make matters worse, because of the technical restrictions in place in these series, opportunities for engineers to learn their craft are heavily restricted as well. Even Formula Student / FSAE teams are so restricted that it's not producing battle-hardened graduates who are good to go either. This situation must be addressed.

To prove the point, my colleagues and I are building up a litany of horror stories of junior engineers simply not understanding the basics, or getting key cardinal performance parameters totally wrong. Take tyre pressures as an example. This is something that should fall into place very quickly in an engineer's journey, yet some of the nonsense I have been hearing recently regarding sky high tyre pressures beggars belief.

In terms of what *should* be happening, the path of my own career provides an enlightening case study. I was fortunate to be right on the crossover between open and spec formulas, so am well positioned to see both sides of the argument. I started in the mid-'90s in Formula Ford 1600, as a gopher working for the equivalent of a pie and a beer. However, that didn't stop me from playing with four-way adjustable dampers or sizing anti-roll bars. During that time, I was also involved

with Formula Holden (Australian F3000) where I was playing around with hydraulically-connected third springs and data.

Later, when I was doing British F3, I was exposed to shaker rigs and what happens when you started to shift aero bits around on a car. Did I know what I was doing back then? Hell no, but I had the opportunity to find out firsthand, and that experience laid the very solid foundations for what I do now.

What this illustrates is that the more technical restrictions you place on the junior series, the less learning opportunities you are giving the engineers of the future. Without that hands-on experience – and remember, getting things wrong is the best way to learn – they simply don't have the knowledge, or the mentorship, required to turn up on the big stage equipped and ready to go.

Wrong turn

So now we know the nature of the problem, how do we fix it? Well, the first part of solving a problem is to recognise there is a problem in the first place, and the huge wrong turn motor racing has taken is thinking it's all about the drivers, so we need to make the cars equal. All that leads to is boring, processional racing (as the early years of GP3 showed). DRS addressed this problem somewhat, but it's only a plaster / Band-Aid. The real solution is to free up the formulas but keep a lid on cost with sensible budget caps. An example of how this could work is illustrated in **table 1**.

The first thing you'll see in the table is fixed price, tub, engine and data acquisition. Note there is nothing spec about who provides any of that. Another big error made in the mid-'90s was the rush to single providers, be it for chassis, engine and / or data acquisition. I was at ground zero when this started happening and now, almost 30 years later, it's obvious that it has been as disastrous as prohibition in the United States in the 1920s. All it has actually done is cull the industrial base of racecar and motorsport component manufacturers.

We've also gone from a situation where individual racecar manuals have degenerated from genuinely informative and useful publications into rough guides. There are some horror stories I will take to the grave on this subject but, suffice to say, if a manufacturer is forced to make a part to a fixed price, something must give. If, on the other hand, you encourage the industrial base to flourish, you re-introduce the much-needed element of competition that is not there with spec parts.

The next point to address is data. One of the most terrifying trends I have witnessed is the backlash against data acquisition. Now, I have spoken on multiple occasions before about this but, in a nutshell, fighting against it only takes away a huge learning opportunity from a generation of motorsport engineers. To illustrate what I mean by that, **figure 1** shows just how much you can do with a base F4 data acquisition package. As usual, actual data is coloured and simulated is black.

Table 1: Matrix for junior formula racing cost control

	F4	F3	F2
Fixed price tub	Yes	Yes	Yes
Fixed price engine	Yes	Yes	Yes
Fixed price gearbox	Yes	Yes	Yes
Data acquisition			
• Fixed price	Yes	Yes	Yes
• Engine temp / pressure	Yes	Yes	Yes
• Brake pressure / throttle	Yes	Yes	Yes
• Tri-axis accelerometer	Yes	Yes	Yes
• Steer / dampers	Yes	Yes	Yes
• Yaw rate sensors	Yes	Yes	Yes
• Strain gauges	No	Yes	Yes
• TPMS	No	Yes	Yes
• Ride height sensors	No	Yes	Yes
• Tyre temp	No	No	Yes
• Individual wheel speeds	No	No	Yes
• Telemetry	No	Yes	Yes
Aero mods	No	Front and rear wing only	Front and rear wing, diffuser and sidepod
Wind tunnel time	No	No	Yes, 5 days only
External CFD time	No	Yes, 2 days only	Yes, 10 days only
External DiL time	No	Yes, 2 days only	Yes, 2 days only
K & C rig access	Yes, 1 day	Yes, 2 days	Yes, 5 days
Shaker rig	2 days	5 days	5 days
Dampers	2-way adjustable, dampers free	3-way adjustable, dampers free	4-way adjustable, dampers free
Engine mods	No, maintenance only	3 engine mods per year	5 engine mods per year
Push-to-pass	0	4	8
Test days	20	20	20
Budget (US$)	500,000	2,500,000	5,000,000

If you encourage the industrial base to flourish, you re-introduce the much-needed element of competition that is not there with spec parts

Missed opportunity

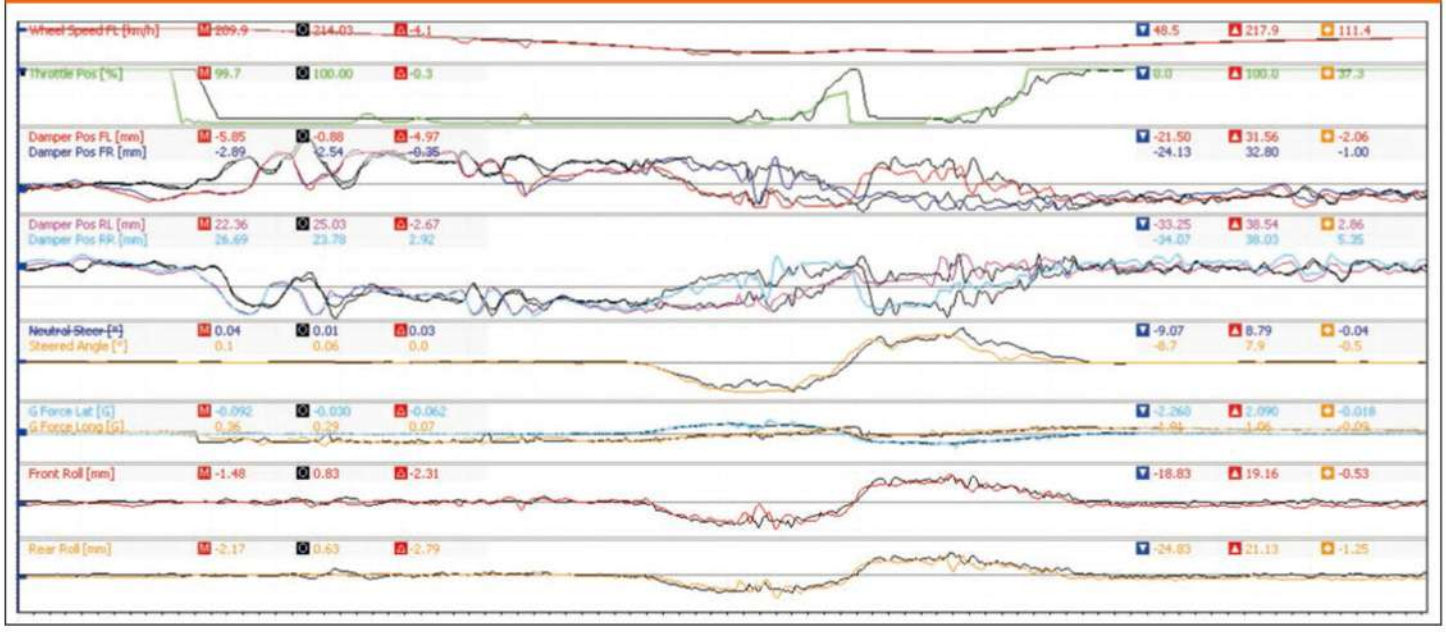
One thing I should expand on here is the graduation of what you are allowed in data. For F4, you have the usual engine channels, along with damper, steering and a tri-axis *g* meter. For the record, this is your entry point for the ChassisSim monster file. Some will contend that in F4 / Formula Ford 2000 / Formula Renault the dominant factor is driver training, and that is true, but the role of the engineer is to understand what happens when they make a change and why it did what it did. The harsh reality here is that if you don't learn this in the junior series, you won't pick it up as you ascend the ladder.

Something I want to address here is the addition of yaw rate sensors across all formulas. This is a change from my last article. The reason I have updated this is I'm working on some stuff right now to deduce handling from race data and reconciling this with the stability channels from ChassisSim. This is showing much promise, and I will come back to that in a future article.

As we go up the ladder, you'll notice in F3 that we introduce strain gauges, tyre pressure monitoring systems (TPMS) and telemetry, while in F2 you get the full shooting match of sensors. The reason for doing it this way is that once you have learnt the basics in F4, introducing further data channels builds nicely on that solid foundation. You still need to be a bit smart about what you do with the data, but you're starting from the right place.

If you haven't already worked it out, the reason we allow the full suite of features in F2 is because that is your final dress rehearsal before entering the big time.

Figure 1: Correlation with an Australian Supercar using the base F4 data package



You'll also notice in our feature spec list that dampers are free. In my view, control and / or locked dampers you cannot adjust are one of the worst things to ever inflict the sport for they rob engineers, and drivers, of crucial experience. The old excuse used to be that rebuilding dampers was hard, or expensive, but that's no longer a valid argument. Firstly, rebuilding a Penske or JRi damper is not hard. Indeed, both companies welcome engineers doing it. And with resources like the ChassisSim damper book and shaker rig toolbox readily available, you can no longer claim ignorance as a defence.

The reason we have gone from two-way dampers in F4 to three-way adjustable in F3 and to four-way adjustable in F2 is because it's a logical progression. Two-way adjustables introduce drivers and engineers to what a damper does, and its effect. As you move up to F3, comfortable in that knowledge, the three-way adjustable introduces you to the difference between low and high-speed adjustments, which prepares you well to get to grips with the full suite of adjustability available in F2.

Aero elephant

The big elephant in the room we need to discuss at this point is allowed aerodynamic modifications. One of the things I adore about hillclimb and Time Attack is the concept that, if you have a good idea, go for it. When you are allowed to play with aero bits, it really opens your mind to what you, and a racecar, can do. It's an invaluable learning experience that every young engineer should go through.

As an example, when I was doing British F3 in 1998, we started to play around with moving the front wing. What an eye opener that was, but such suck-it-and-see engineering used to be par for the course in open-wheel racing. Now, the big teams are shocked and shaken when they get caught with their pants down. The recent porpoising fiasco in F1 is a perfect case in point.

Too many regulators these days think that allowing teams to play with wings and floors is going to bring about the end of the world, but nothing could be further from the truth. You only have to look at aero modellers and amateur aircraft builders to see that this avenue of thought has zero basis in fact.

However, it all comes with caveats, and they are there for a deliberate reason. Firstly, you'll notice that in **table 1** wind tunnel time is highly restricted. Ditto with external CFD companies. This is for two key reasons. Firstly, to control costs. Secondly, to force teams to use off-the-shelf solutions so they learn the valuable skill of making the best of what they have, and to build a fundamental awareness of the numbers.

You'll also notice there are other restrictions in the list on shaker rig, K&C rig and external driver-in-the-loop rig testing. Again, this is to keep a lid on costs, but also because, except for the K&C rig, the rest can be taken in-house. I should know, for it's the bread and butter of my business.

Engine features

One further thing I do want to touch upon is the engine features I have outlined. For me, throughout my career, the engine has pretty much been a black box you don't touch. What saved my neck on this one was my tenure at Haltech Engine Management Systems between 2002 and 2006. There, I was introduced to engine tuning and what engine modifications did. Guess what? That's proved pretty useful in the years since.

Unfortunately, just like with chassis / vehicle dynamics, our engine builder brethren have also been caught in the straight jacket of spec components. This too needs addressing.

The real thing

The final thing I want to mention is the test day allowance. Without a shadow of a doubt, the biggest mistake in the current-era F1 in my opinion has been the ban on private testing of current cars. Yes, it was a knee jerk reaction to the dedicated test teams running nearly 365 days a year in the 1980s and '90s. Granted, that was a bit silly. However, the current situation is every bit as ridiculous. Here's why. One of the worst kept secrets in the business of motorsport is that simulation and DiL rigs are no replacement for the real thing. They are fantastic tools in their own right, and give you a deep knowledge of the car (the key reason I've increased the test allowance to 20 days throughout all series in my analysis), but they are not a replacement for seat time on track in the real car, and to pretend otherwise is akin to denying there is a river in Egypt.

There will, of course, be some naysayers claiming this will ruin the show. The evidence to the contrary is plain for all to see in hillclimb events like Pikes Peak and Time Attack where, if you have a good idea and can exploit it, you can leapfrog the grid and win. I should know, I've been at the coal face long enough to see this happen and, when it has, it's been a fantastic part of 'the show'.

Given how my suggestion has been structured, particularly with the budget caps, everyone knows what the price is and accepts there will be times when they are in front, and times when they'll be playing catch up. That's motor racing and, if you don't like those odds, perhaps you're in the wrong business.

The quiet revolution

Strengthening and broadening motorsport from the bottom of the pyramid up is key to Tim Mayer's vision for the FIA

By ANDREW COTTON

The presidency of the FIA is up for grabs. At the end of 2025, there will be an opportunity to challenge sitting president, Mohammed Ben Sulayem, for the position. Following the decision of Carlos Sainz not to enter the race and focus on his own racing ambitions, former FIA steward, Tim Mayer, stepped out of the shadows in July to launch his campaign for presidency, amid a flurry of media activity.

Mayer has a tough job ahead of him to convince the 245 voting ASNs (National Sporting Authorities) that he should be given their support. To do this, he must persuade the ASNs around the world that his vision of what the FIA should look like deserves their vote, but that will be both time consuming and costly.

'I am very fortunate that there is a coalition of people who are helping me fund this,' says Mayer. 'There is a worldwide group of people that are not happy with the *status quo* and, in my 34 years of motorsports management, I've developed a lot of allies.'

In those 34 years, Mayer has been a senior VP for racing operations in IndyCar, chief operating officer at IMSA and the American Le Mans Series and has been a member of the board of directors of the United States ASN since 1998. He has also worked as an FIA Commission member and ASN delegate, as well as an organiser of Formula E, FIA World Endurance Championship, touring car and rallycross events. To say he has broad experience in racing is an understatement.

With experience in IndyCar, IMSA, ALMS, Formula E, WEC, touring cars and rallycross, Mayer is very well positioned to compete for the FIA presidency

From the ground up

With that track record, Mayer is convinced his policies will get him noticed. Under his vision, the FIA needs to increase the base of the motor racing pyramid, improving opportunities for smaller companies and individuals to become involved in racing without bankrupting their business. His target is to drive down the cost of building a competition car, and he intends to start with karting. 'It's about saying okay, here's my wallet, it's empty, how do I go karting? How do I get there?' says Mayer. 'That, as the FIA, has to be our starting point, not the other way around.'

[Mayer's] target is to drive down the cost of building a competition car, and he intends to start with karting

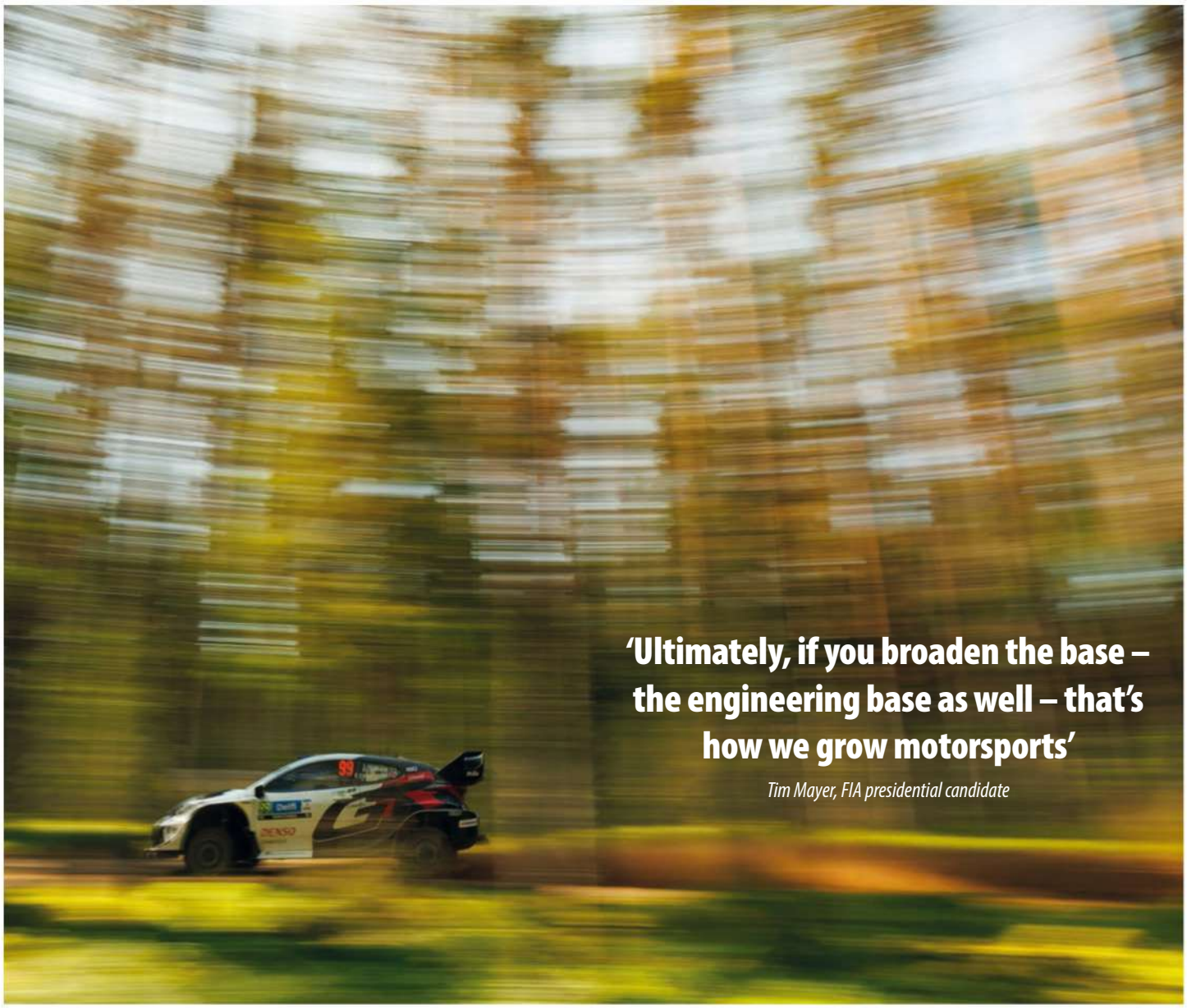
Developing the grass roots of racing is a common theme among presidential candidates, but Mayer is clear that the FIA needs to create opportunities, and then release the Intellectual Property rights to the ASNs in a bid to encourage racing in all areas of the world, no matter how remote, or what that country's racing history may be.

Having looked at the cost of karts, also on the radar is the circuits on which cars can race. Right now, building even a kart track is complicated and expensive. 'We shouldn't make it so difficult that you are required to engage some multi-million dollar engineering firm,' says Mayer. 'We should have off-the-shelf solutions for you to be able to do it with a Google Earth map and a hand-held calculator.

'By doing those things, we can help to drive motorsport around the world. Ultimately, if you broaden the base – the engineering base as well – that's how we grow motorsports. The world championships take care of themselves, it's the club sport that needs love and attention, and it needs that focus from the FIA.'

Roots manoeuvre

His intention is literally to start at the grass roots, enabling lawnmower manufacturers to step into karting. However, the racing ladder quickly becomes much more expensive once you



'Ultimately, if you broaden the base – the engineering base as well – that's how we grow motorsports'

Tim Mayer, FIA presidential candidate

The WRC is a case in point for cost reduction. For decades it has been supported by privateers, but more recently has become so expensive to compete that even manufacturers are being driven out

reach the level of FIA Formula Regional and Formula 4. It's a big ask for a driver, team or engineer to make that step up.

'In the US, we have a range of championships that run under the various clubs, and you have a lot more choice as a young kid coming in, or as a parent trying to drive your kid through,' says Mayer. 'Do I go through the IndyCar route, or Road to Indy ladder? Do I go through IMSA, or do I hybrid and jump from one to another?

'It's that diversity of championships that allows that to happen. The problem with having a limited set of championships is that you drive up cost.'

Right now, motor racing companies are dwindling in major championships as the FIA follows a model of securing a medium-term

As well as being COO at IMSA, Mayer has been on the board of the US ASN since 1988

future for a smaller number of suppliers, rather than allowing all the existing ones to battle it out in open competition. The concept of single supplier and long homologation periods has rewarded larger, more established companies, but pushed others into looking for business in lower, less lucrative formulas to stay solvent.

Mayer treads a fine line between the two philosophies: 'You have so much opportunity for one person to succeed a little bit better on chassis stiffness, or something like that, and everybody rushes from chassis to chassis. But then nobody is profitable and, if nobody is profitable, that doesn't work either.

'For me, the diversity has to start at a slightly lower level, where the cost of entry

into that marketplace isn't so daunting, or you need tens of millions of dollars to set up your manufacturing base to build just 10 chassis a year.

'We have to work on diversifying, where you can build 50-100 low-cost Formula Ford chassis, for instance, or some other formula at that level. From there, the cream will rise to the top and can continue to invest.

'We must have a broader base to this pyramid, otherwise the price point to start is going to be too high. Then, with careful stewardship at the top, the marketplace tends to take care of itself, but if you have destroyed the bottom of the pyramid then you're in trouble.'

Generating the workforce to exploit new technologies such as artificial intelligence is not, says Mayer, the role of the FIA. Its job is to work with the ASNs to promote STEM subjects in their own areas, and for the technologies to filter down from top level to lower racing categories. Then, students will start to look at how to manage the technologies at school and university.

Plugging the gaps

Some holes have emerged in the FIA arsenal, including the defunct World Touring Car Championship (WTCC), and the World Rally Championship. While Malcolm Wilson is heading up a group in the FIA to finalise the 2027 WRC regulations, there is not much forward movement in the touring car world. That has been left to Marcello Lotti and his TCR rules. The FIA has partnered with him to form the Kumho TCR World Tour but its a long way from the heyday of the WTCC.

Under Lotti, the WTCC flourished, until the FIA, then under Jean Todt, brought in the TC1 rule set in 2014. The rules demanded more expensive technology, the FIA wanting to make them exceptional compared to other domestic series. The problem was the old cars could be sold to the domestic series, while the new ones were too expensive. They were also not very popular, as they barely resembled their roadgoing counterparts. As usual, the series relied heavily on its privateers, but they could not, or did not wish to, afford the cars either.

'The regulations have to be relevant, and I'm always open to talking about what's relevant. Tradition is built on good ideas'

Tim Mayer

Mayer is clear that, while manufacturer involvement is critical to the future of racing – notably around developing environmentally-friendly fuels and new technologies – the privateers who keep so many series running also need a place to race. 'Touring cars left the FIA fold in a large part because the FIA continually wanted to add complexity to the regulations. Ultimately, touring car racing said you are making it impossible for us to be part of the FIA. Again, this is one of those cost / complexity / culture questions. There are plenty of good touring car series; the touring car ecosystem is actually alive and well in its own right and should easily fall within the FIA. But again, it's a matter of sitting down with the partners and treating them like partners, showing them a little bit of respect.'

Solid foundations

Could an FIA touring car follow a similar path to the proposed new rallying regulations, with a standard spaceframe and a variety of body options, including CUVs, as the outer skin? Mayer isn't opposed to that idea: 'Just because we all sat down in 1960 and decided then what we thought a touring car was doesn't mean it's entirely relevant today,' says the 59-year old. 'The regulations have to be relevant, and I'm always open to talking about what's relevant. Tradition is built on good ideas.'

Privateers on parade

For the WRC, it too is now relying on manufacturer participation, due to the cost and high levels of technology. 'We have more or less eliminated privateers out of that category,' says Mayer. 'On any given rally there should be 100 cars tipping up into the service park and wanting to go out there and compete. We made it extremely complex for privateers to come and do that.

'On the other hand, there are some fairly healthy national rallies happening right now. We need to look at where they are focusing and how do we simplify?'

The WRC regulations for 2027 are currently being finalised and will soon be voted on, but that may be late for a big entry list when the cars are built and ready for the Monte Carlo, says Mayer: 'This comes from this kind of reactionary rule making process. Instead of going to all the manufacturers – the ones that are in the championship and the ones that are not – and asking where would you like to see this in 10 years' time, we are asking what will keep you in for the next two years?'

Mayer is under no illusion. There is an ocean yet to cross for him, and any other presidential candidate who may emerge, before the election which will take place on December 12, and it remains to be seen who will be at the helm of motorsport's most powerful governing body when these new regulations are ushered in.

Whoever it is will have their work cut out. Throughout the FIA's remit, there are new regulations that will be delivered during a time when car manufacturers are looking closely at their own futures and stability. Tracing the right path through the introduction of new fuels will also be tricky. The president will need to navigate the choppy waters carefully.

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New Goodyear GT3 compound

US tyre company, Goodyear, which provides rubber to the LMGT3 class of the FIA World Endurance Championship, introduced a new hard compound for the fifth round of the 2025 season in Brazil. The Goodyear Eagle hard LMGT3 tyre is designed to better handle double stints on highly abrasive circuits.

'At Le Mans, we heard from many teams that the tyre could have lasted longer than four stints, but they were changing tyres prematurely due to driver changes and drive time limits,' says Mike McGregor, Goodyear's head of endurance racing EMEA. 'Teams were running the tyre for four stints even on the test day, when we would normally expect them to run a tyre for two, maybe three stints, due to the track not being rubbered in until later in the race week.'

Teams competing in the category can only use one tyre compound per round, which Goodyear selects. The new hard compound will be used at Circuit of The Americas in September, and at Bahrain International Circuit in November, while the medium will be used at Fuji Speedway.

Teams competing in the European Le Mans Series will continue to use Goodyear's medium compound for the remainder of the season.

The Goodyear Eagle hard LMGT3 tyre is designed to cope with double stints on the more abrasive surfaces of the FIA World Endurance Championship

SEEN: DEFENDER DAKAR D7X-R

Jaguar Land Rover brand, Defender, presented its latest off-road rally challenger that will take on the Dakar Rally and World Rally Raid Championship in 2026. The Defender Dakar D7X-R will compete in a newly-created 'Stock' category for production-based vehicles. It features the same architecture as the roadgoing Defender, with a lightweight aluminium monocoque, and is powered by a 4.4-litre, twin-turbo V8. The rally raid version of the car features new, 17in wheels with 35in tyres for increased durability, an enhanced steering rack and a new exhaust system.

Ligier launches 650bhp GT

French constructor, Ligier, has launched a new, carbon monocoque GT car built for endurance racing.

The JS2 RS meets with 2025 LMP3 static load tests and is powered by a Ford 3.5-litre, twin-turbo, EcoBoost V6 producing 650bhp. It features a Sadev SL90-20 Evo gearbox with sequential shifting, Öhlins TTX36 dampers and Brembo brakes with six-piston calipers. ABS is managed by Bosch, the ECU by MoTeC.

Ligier says it has worked hard to keep costs under control, while also increasing safety features for the non-professional drivers it hopes to serve. The JS2 RS costs €255,000 (approx. $296,500) plus taxes.

Simultaneously, Ligier has continued to develop the junior JS2 R, which has sold more than 120 units. It now sports a normally aspirated Ford 3.5-litre V6. Having both direct and port fuel injection maintains the 350bhp power output from the outgoing 3.7-litre V6, which was only port-injected. There is also a new brake system, better lubrication for the transmission to increase durability and reinforced pivots.

Ligier launched the tubular-chassis JS2 R in 2018, mainly for its own European race series, and has now added a step above with the carbon-based JS2 RS

Supercars summit in the US

General Motors has offered its teams competing in the Australian Supercars Championship access to its technical facility in a bid to increase their competitiveness following the defection of Triple Eight to Ford.

The move means only four teams will run Chevrolet Camaros next year, including Matt Stone Racing and Erebus Motorsport, who will have access to some of GM's NASCAR teams, including Trackhouse. The teams will also have meetings with GM Motorsport boss, Eric Warren.

According to speedcafe.com, GM wants team principals and key engineers from all four teams to attend the engineering-focused trip, while drivers may be included in similar trips in the future.

Aero test limits updated as 2026 cars draw nearer

Formula 1 teams have been given revised aerodynamic testing limits for the rest of 2025 as part of a mid-season refresh based on the World Constructors' Championship standings. The FIA restricts the number of hours a team may spend in the wind tunnel and the number of CFD items it may simulate, with those limits reducing the higher teams are up the table. The idea is to promote close competition by giving lower positioned teams more off-track testing time. Track testing is restricted to a few days before the season kicks off, so most validation work is undertaken in the wind tunnel or via software.

McLaren had the lowest Aerodynamic Testing Regulation (ATR) allowance for the first half of 2025, and still has following its strong start to the current campaign. The Woking-based team is allowed 70 per cent of the base 320 wind tunnel runs and 2000 CFD items available. The aero test allocations then increase on a sliding scale for each subsequent position in the table. Mercedes, which was second at the time of the ATR being reset in late June, can operate to 75 per cent of the base values, whereas in the first half of the year it was at 85 per cent because it finished fourth in 2024. Williams has seen the biggest loss of testing allowance, while last-placed Alpine has gained the most, its allocation going up from 95 per cent to 115 per cent.

American manufacturer Cadillac, which joins the grid in 2026, has been utilising the Toyota wind tunnel in Cologne, Germany. It also has 115 per cent of the base value, equating to 336 wind tunnel tests, and 2300 CFD items.

IN BRIEF

In a widely anticipated move, Team Penske has appointed Jonathan Diuguid as racing president and Travis Law as the new competition director. The two posts became vacant following the drama at this year's Indy 500 with non-conforming rear crash structures on the Penske cars. Tim Cindric was consequently relieved of his post as president, along with managing director Ron Ruzewski and team manager Kyle Moyer. Diuguid will lead Team Penske's programmes in IndyCar and sportscars.

Audi's Formula 1 project took a further step forward with the opening of a new base at Bicester Motion, a former airfield that has been converted to business use in the heart of the UK's Motorsport Valley. Its purpose is to help the German squad tap into the region's engineering talent.

Red Bull has parted company with its Formula 1 team principal, Christian Horner, after 20 years at the helm. The Briton was informed of the decision shortly after the British Grand Prix in July. He is replaced by Laurent Mekies.

Stratasys Limited has marked the 10th anniversary of the launch of its 450mc 3D printer with an upgrade that includes hardened components, an all-materials licence for full access to the 450mc portfolio and a one-year licence for GrabCAD Streamline Pro and Print Pro programmes.

Motorsport UK has extended its agreement for TOCA to operate and promote the British Touring Car Championship until the end of 2031. '[This agreement] enables us to commit to our updated technical regulations for 2027 and beyond,' says Alan Gow, BTCC chief executive. The technical regulations, which will take effect for the 2027 season, were due to be released after *Racecar* went to press.

The Nissan Formula E team has extended its relationship with lubricant supplier Shell. The two have worked together to develop a bespoke range of transmission and thermal fluids.

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Seize the opportunity

The welcome side effect of the rise in popularity of F1 around the globe

All in the business of motorsport are again facing difficult times, due to constantly changing international and local targets by governments around the world. However, in spite of these, many in our motorsport community are enjoying great success.

Total Motorsport Valley revenues, identified in a recent review by Grant Thornton and the MIA, have almost doubled in the past 10 years, from £9bn to £16bn, largely inspired by the enormous popularity of Formula 1. A welcome effect of Liberty Media's investment in F1 is that it now attracts 830 million global fans from attendance, broadcast and digital, of which 40 per cent are women.

I recommend you secure a copy of the review via the QR code at the bottom of this page, as it will help with your future plans, and in attracting investors or financial support. When seeing the strength of our motorsport industry in these uncertain times, they will surely understand that investment in our sector is a wise one.

In 2025, Motorsport Valley, which already hosts the majority of Formula 1 teams, and their key suppliers, will become home to the new Cadillac F1 squad at Silverstone, as well as a technology centre for Sauber in Bicester. This is good news for the vital supply chain, many of whom are members of the MIA. They will gain more customers, not only from F1 but other leading motorsport series.

F1 celebration

Make no mistake, the impact of the celebration of 75 years of F1 in the UK, held at the British Grand Prix, Silverstone, reached high levels of commercially valuable influence. Let's not forget the world's first racetrack was built in the UK, at Brooklands, and now our F1 grand prix attracts 500,000 spectators – an exceptional record.

The UK prime minister held a celebration at 10 Downing street, which the MIA attended. Hopefully, this government will now wake up to the value of supporting our successful, globally-recognised, technology-based business cluster. Why this has been largely overlooked by previous governments is a mystery but, as this current government desperately needs to champion some business winners, our industry, and F1, could provide just what it needs.

The MIA is involved in a range of issues on behalf of our industry, from securing future R&D tax credits to sensible tariff solutions and a better understanding of the problems caused by Brexit to the movement of products in and out of the UK and Europe, among many others. I encourage you to check our website (www.the-mia.com) and consider becoming a member of the MIA. We need to help one another to overcome these difficult times. We have done this before, with financial crises and Covid, but now is the time to take advantage of the popularity of motorsport to guarantee our success into the future.

F1's increasing popularity has spurred growth in Motorsport Valley revenues

We are at the centre of something really special, as our business embraces new media and entertainment, as well as technology and competitive engineering. The situation is uncannily similar to successful US clusters of media in Hollywood and advanced technology in Silicon Valley. The addition of entertainment and media to our business credentials is attracting the interest of millions of families, young people and investors. We *must* make the most of this opportunity.

The challenge for jobs will become intense, and international, attracting the most talented candidates as it continues to grow. The UK has an excellent pool of engineering and technology-skilled individuals, many of whom will consider joining the well-rewarded motorsport supply chain, which now offers a future in an exciting international industry. This, in turn, will bring demand from young people to study relevant education and apprenticeships or degrees.

Existing companies will grow, and new ones will be created as the supply chain for global motorsport is an attractive, lucrative marketplace.

Jobs in motorsport are demanding, but generally well paid, focused on providing excellent solutions to a competitive engineering customer base. From junior to senior positions, all require energy, skill, enthusiasm and a will to win.

Our recent Motorsport Valley report shows we have grown revenues by 80 per cent in the past decade, and spend an average of 14 per cent on R&D, twice that of the automotive industry. Powerful figures.

On 16-17 October, this fast growing and valuable industry will again come together in the Silverstone Wing at the MIA's popular CTS Motorsport Technology and Engineering Show. It's free to attend for all in the motorsport trade or business, and we expect well over 100 exhibitors and many thousands of trade visitors over two days, so please do join us (see www.the-mia.com/event/MIACTS25).

Strong position

I remain convinced that if we move quickly and together we are in a strong position to enjoy business growth and see a substantial increase in demand, which the motorsport supply chain must be in a position to meet. As the industry is growing so fast, there will be a constant need for new suppliers across many areas to help the community handle this growth, both in the UK and internationally. The MIA, the only industry association for the business world of motorsport, welcomes hearing from anyone interested in the many business opportunities offered by the Motorsport Valley supply chain.

These are tough times but, at the same time, there is an open window to growth opportunities. I encourage you to make contact with the MIA team, who look forward to helping you make an even greater success of your business.

Chris Aylett is CEO of the MIA (Motorsport Industry Association) www.the-mia.com

Scan the QR code to access the 2024 industry report of the UK's motorsport and high-performance engineering sector, created by Grant Thornton and the MIA

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Engineering and AI

AI is not the enemy. Nor is it a silver bullet that will solve everything. It is an emerging technology that needs to be nurtured and worked with, and that starts with investment in education

Artificial intelligence sparks reactions. Some fear its influence on society, as the potential is unknown, while others embrace the ease of use and its contribution to society. The Advanced Engineering Show, held at the NEC in Birmingham, UK on 29-30 October aims to examine the influence of this new technology and how it can best be used.

Discussions will not be about whether or not a company should use AI, as the technology is here, and already influencing how engineering and manufacturing is working. From predictive maintenance to real-time optimisation, AI is driving smarter, faster and more autonomous operations. No less than 91 per cent of companies are planning to increase their investment in AI technology over the next two years.

Like it or not, AI is here. Those who will become most successful in engineering the future need to embrace the challenge and ensure their workforce is fit for purpose

While investment is ramping up, there is a growing concern that the skilled people needed to manage and scale these systems are not entering the workforce fast enough. Part of the problem is a lingering misconception that AI is something you can simply buy off the shelf.

Building trust

The reality is AI is a tool that only delivers value when it is supported by the right strategy, quality data and skilled talent. AI can happily crunch numbers, or generate solutions, but it can't negotiate, lead a team or build trust with stakeholders. These are still distinctly human skills. Leaders in engineering don't therefore all need to become coders, but they do need to understand how AI works, what its limitations are and how to ask the right questions when making strategic decisions.

This is where blind adoption becomes a huge part of the equation. AI systems are built on data, and there is bias in how data is collected, and in the algorithms themselves. Without the layer of human oversight, there is a very real risk that AI could lead us down the wrong path, and fast. This is important as we move into the next phase of AI, called agentic AI. These aren't just systems that follow instructions. They are designed to act independently, make decisions in real time and respond to complex environments without waiting for human input. Built on large language models (LLM) and advanced contextual understanding, agentic AI promises to introduce new levels of autonomy.

With that comes greater responsibility, and the need for careful human guidance. Trust in AI must be earned, which depends on having the right people involved at every level, not just in monitoring what the system is doing, but dictating what it's doing in the first place.

To meet this challenge, industries need people who understand data. Programming and machine learning will be crucial, not just in developing AI tools but also in maintaining and improving them.

An emerging area of focus is prompt engineering, which is about understanding how to communicate with AI systems effectively, using the right language, structure and context to generate useful and accurate responses. Closely linked to this is natural language processing (NLP), another fast-growing field. NLP allows machines to interpret, understand and respond to human language, whether that's written commands, spoken queries or even messy, unstructured data.

As a result, data scientists, machine learning specialists and NLP engineers are quickly becoming core to manufacturing and engineering teams. However, there are still a few systemic gaps, and one of them is in education. Coding and data science need to be embedded much earlier in the curriculum, and not just at university level, but in secondary schools, T levels and vocational training programmes.

Unfortunately, too many young people still think of engineering as dirty, manual work. AI offers a chance to re-frame that perception. Today's engineering roles involve an incredible amount of creative work using robotics, sensors, software and data science to design and operate today's innovative technologies.

Plan of Action

The UK's AI Action Plan set out a framework, but it is not always clear how the proposed investment will be delivered. What is missing is a voice at the top; someone in government who understands engineering and manufacturing first-hand and can speak to the real issues facing the sector. Funding and programmes are available but, with AI evolving so rapidly, there's a real risk of students falling behind while the government catches up.

In the meantime, companies must take responsibility for building their own future workforce. Small scale pilot projects are an effective way to begin trialling AI on a specific process or production line to learn what works and where internal gaps exist. Support from organisations like Made Smarter is invaluable in this regard. Made Smarter offers training, online courses and funding to help companies begin their AI journey in a manageable way.

Initiatives such as Advanced Engineering UK's ongoing #MINDTHEskillsGAP are also helping tackle the skills gap in the industry. The campaign calls for closer collaboration between industry leaders and policy makers to develop solutions that will secure the next generation of engineering talent, especially in hi-tech areas like AI and automation.

In addition, the show recently announced its 'Unsung Heroes in Manufacturing' initiative to support the efforts of this campaign. A searchable online library of industry experts has been created to provide easier access to real-world voices, not only reflecting the full spectrum of manufacturing and engineering expertise, but enabling a connection between upcoming engineers and industry experts.

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Racecar engineering
Inside the world of modern motorsport technology

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Subscription rates
UK (12 issues) £84
Europe (12 issues) €99
ROW (12 issues) USD$113

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News distribution
Seymour International Ltd, 2 East Poultry Avenue, London EC1A 9PT
Tel +44 (0) 20 7429 4000
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Email info@seymour.co.uk

Racecar Engineering (ISSN No: 0961-1096, USPS No: 463) is published monthly by The Chelsea Magazine Company Limited, and distributed in the USA by Asendia USA, 701 Ashland Ave, Folcroft PA.

POSTMASTER: send address changes to Racecar Engineering, 701 Ashland Ave, Folcroft, PA. 19032.

Printed by Walstead Roche Ltd
Printed in England
ISSN No 0961-1096
USPS No 007-969

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TELEGRAPH MEDIA GROUP

www.racecar-engineering.com

Sense and sensibility

From taboo to necessity, the inevitable rise of torque sensors

The issue of torque sensor control has been a hot topic in recent months, and will be a major talking point again in the coming year as Formula 1 gears up for its new regulations. The sensors that are used in FIA series, including Formula 1 and the WEC, are made in California by MagCanica, but other suppliers are starting to reach a similar level of accuracy and organisers are hoping their products will be robust enough for other series' racing needs. The question that follows is how can the technology be introduced, and be affordable?

Typically, Formula 1 teams will look for bespoke designs, rather than simply choosing an off-the-shelf part. It's the same for their cooling systems, leaving the supplier, PWR, with a headache to produce what's needed. This becomes even more of a challenge when teams are preparing for new regulations in 2026. Thankfully, simulation has come a long way since the last major rule change in 2014, so they should have a clearer idea this time around.

Back to torque sensors, though. They serve different functions in the various championships in which they are used. In the WEC, they are used to regulate power output at the wheels. The task for the team engineers is to get as close to the torque limit as possible without exceeding it. Spikes in power levels, over bumps and kerbs, are penalised, so teams must leave a margin, or work hard on their software to ensure they don't pick up a penalty. It is a very complex task.

Coping mechanisms

Teams also have to make sure their sensors are properly serviced, have power fed to them (apparently, not necessarily the case at Le Mans in June) and know how to manage the system to cope with any anomalies in data. The sensors can drift in their baseline data fed back to the organisation, which can lead to drama in race conditions.

All this means teams have to employ engineers solely dedicated to the torque sensor system, which adds to their cost. Cash is always a sensitive topic among racing organisations so, in response, MagCanica has fixed its pricing at $9000 (approx. £6600) per calibrated sensor for another year. A pair of sensors, mounted to the driveshafts and ready to go, should be around $25,000 (approx. £18,350) says the company. However, as sole supplier to many championships, MagCanica has to produce an excess number of sensors, for different applications. It has to either hold them in stock, or send them to European distributors to stock them and sell on to the user.

For other series, such as the GT World Challenge, torque sensors have been a taboo subject. With around 200 of the latest GT3 models in competition against some older cars, introducing such technology in volume would, it was said, threaten grid sizes as teams would need to invest heavily.

Turning tide

At the 24 Hours of Spa, however, even manufacturers that initially held out against the sensors admitted they were now necessary. Well, all bar BMW, which remains implacably opposed to the technology on the grounds of cost and additional complexity to its customer teams. The company's motorsport boss, Andreas Roos, pointed out to me at Spa that someone would have to pay for the sensors, either the manufacturer or the customer, before you even get into the topic of holding spare driveshafts for various applications, in different series (see *RE* V35N7).

To ensure a level playing field, particularly at night in a 24-hour race when the temperatures drop and the turbo cars come into their own, sensing equipment is now considered a necessity by the vast majority. The series is therefore now looking to use them as a monitoring device, which would incur a cheaper installation cost and mean teams would not need to invest so heavily in staff. Right now, the SRO is testing the concept in the DTM and, if it works, will look at cost-effective ways of introducing it in the years to come.

The whole ecosystem needs to update to meet this growing demand

Meanwhile, MagCanica is growing in size, adding test benches and increasing capacity in the hope it will also land a deal with NASCAR, alongside its FIA contracts. The American organisation has already tested sensors in private sessions, and plans to trial them in race conditions before introducing them within the next few years. That will then allow NASCAR to open up its engine regulations to allow configurations other than traditional V8s.

The FIA World Rally Championship is also looking at introducing torque sensors, although how that would work is open to question. If a kerb strike on a smooth circuit sends the data haywire, how will they fare off road?

If this all goes ahead, there will be a need for more companies, more supply (probably in Europe to avoid tariffs), faster turnaround times and cheaper solutions. The whole ecosystem needs to update to meet this growing demand. Only when that happens will torque sensors, like fuel flow meters, cease to be a topic of conversation.

ANDREW COTTON Editor

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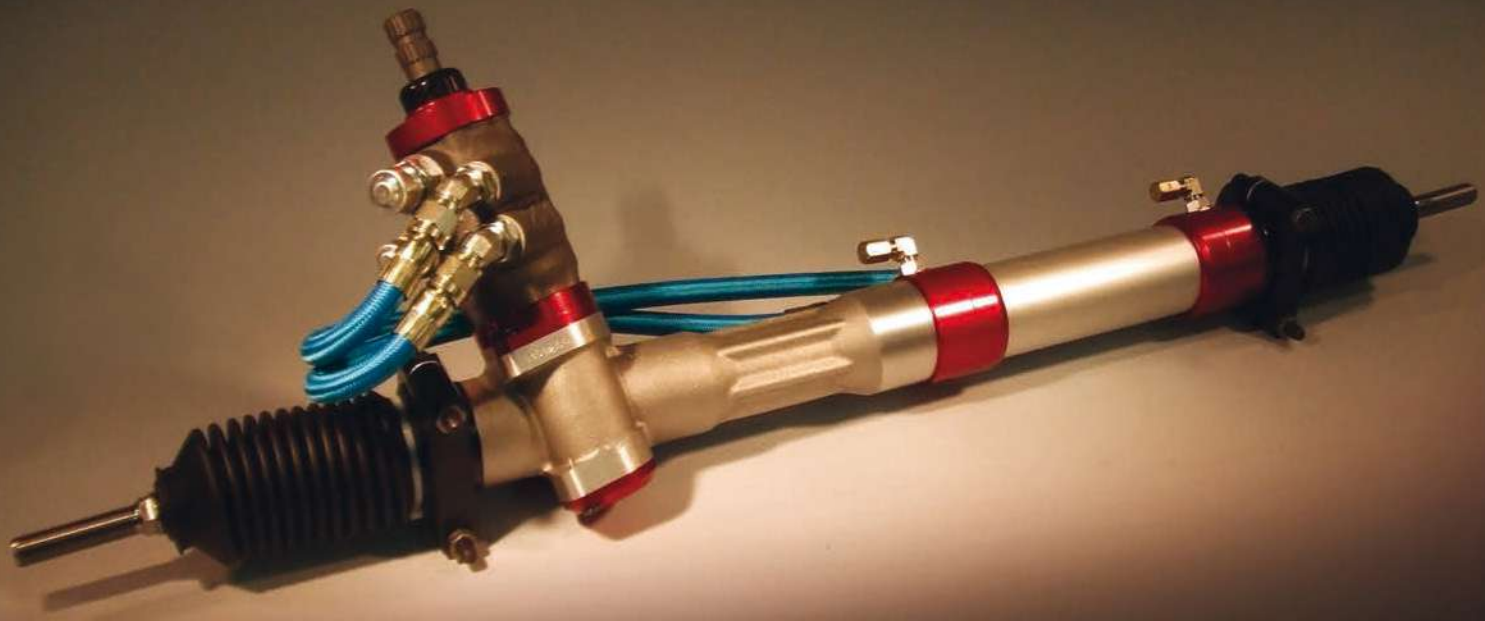

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